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Secondary Math Teachers' Implementation of Language Supports for English Learners

A dissertation submitted in partial satisfaction of the

requirements for the degree Doctor of Education

by

Christina Euridici Apostolakis

2019

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ABSTRACT OF THE DISSERTATION

Secondary Math Teachers' Implementation of Language Supports for English Learners

by

Christina Euridici Apostolakis

Doctor of Education

University of California, Los Angeles, 2019

Professor Mark P. Hansen, Chair

The academic language in mathematics classes is challenging, and teachers need to actively support students' acquisition of the language of the discipline (Cirillo, Bruna, & Herbel-Eisenmann, 2010; Moschkovich, 2012, May 2015; Schleppegrell, 2007; Usiskin, 1996; Zweirs, 2017). The difficulty of math language affects English Learners (ELs) students in many ways, including performing lower than their non-linguistically diverse peers on high-stakes exams in math (Abedi & Gandara, 2006; Abedi & Lord, 2001; Clark-Gareca, 2016). This mixed-methods study investigated the language strategies secondary math teachers employed to support the ELs in their classroom and explored possible influences on the implementation of these strategies. Thirty-nine teachers completed a questionnaire about their attitudes, beliefs, and practices. Seven of those teachers were subsequently observed teaching and participated in a follow-up interview. The frequency of five EL strategies (Sentence Starters, Structured Engagement, Think Aloud, Reciprocal Teaching, Vocabulary Instruction) were investigated. The Precede-Proceed Planning Model was adapted in order to generate hypotheses about possible predisposing, reinforcement, and enabling factors affecting the use of these strategies (Crosby & Noar, 2011). I investigated

associations between the hypothesized factors and implementation. I also obtained teacher perspectives on possible barriers.

Through the analysis of the questionnaire, observation, and interview data, it was found which strategies teachers said they used the most, what strategies teachers said were important to support ELs, and obtained a glimpse into possible factors that may influence math teachers' implementation of EL strategies. The teachers said they used Think Aloud, Structured Engagement, and Sentence Starters most frequently. Reciprocal Teaching and Vocabulary Instruction were used least frequently. The interviewed teachers shared that they also found planning with language in mind and creating a positive classroom culture was important to helping them support their ELs. There was a positive association between feeling unprepared and the frequency of use of Vocabulary Instruction, which helps provide insight into how Professional Development can be used to help teachers feel more prepared. Teachers asked for on-going Professional Development on EL strategies, with clear examples of how to implement the strategies and time to work on getting better at them. This study provided insights into how Professional Development efforts could be formulated to help teachers feel more prepared to support their ELs.

The dissertation of Christina Euridici Apostolakis is approved.

Matthew Madison

José-Felipe Martínez-Fernandez

James W. Stigler

Mark P. Hansen, Committee Chair

University of California, Los Angeles

2019

DEDICATION

To my first and best teachers

Victoria and George Apostolakis

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ACKNOWLEDGMENTS

I thank my thesis advisor, Professor Mark Hansen, for his guidance, patience, and support during my work.

I also wish to thank my committee members, Professors Matthew Madison, José-Felipe Martínez-Fernandez, and James W. Stigler for their insight and support of this study.

I am grateful to the teachers who generously gave their time to answer my questionnaire and participate in the observation and interviews.

I thank Carly Sprano, Ryan McDonnell, and Kristin Botello for pushing me as an educator and inspiring me to do this work.

Finally, I express my gratitude to my family for their unwavering support during this study.

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CHAPTER ONE

Statement of the Problem

Though much is known about effective research-based strategies to facilitate the language development of English Language Learners (ELs) in middle and high school mathematics classrooms (Carr et al., 2009; Chamot, 2009; Moschkovich, May 2015), many mathematics teachers struggle to implement these strategies that increase ELs mastery of mathematics. Understanding this gap between sustainable implementation and the research will help districts and schools support their math teachers, so all their students can succeed in mathematics.

This study investigated teachers' utilization of language supports for ELs at various language proficiency levels and possible challenges teachers face in implementation in urban, low-income middle and high schools. ELs are defined as students whose original language is not English and who have yet to pass the required assessment to be re-designated as English proficient in listening, speaking, reading, and writing (California Department of Education, 2015). As a consequence, they struggle with the vocabulary and syntax within the language of mathematics in classrooms and on high stakes assessments (Abedi, 2006; Abedi & Gandara, 2006; Abedi & Lord, 2001; Abedi, Lord, & Hofstetter, 1998; California Department of Education, 2017; Human Resources Research Organization, 2013; Kieffer, Lesaux, Rivera, & Francis, 2009; Kopriva, Emick, Hipolito-Delgado, & Cameron, 2007; Martiniello, 2008). In this study, I investigated the possible factors that affect middle and high school teacher implementation of EL strategies and identified the strategies teachers say are helpful in their classrooms. I first administered a survey to 39 secondary math teachers. Next, I observed and interviewed seven teachers, to further investigate their instructional practices for ELs.

In order to help these students develop their math proficiency while still learning English, teachers use accommodations such as sentence starters or extra time, to provide a different pathway that does not reduce rigor for ELs to access the math content (Clark-Gareca, 2016; Wolf, Kao, Rivera, & Chang, 2012). Despite knowledge of accommodations, math teachers lack training to support English learners effectively within their classrooms (Gandara & Contreras, 2009; Gandara, Rumberger, Maxwell-Jolly, & Callahan, 2003; Lopes-Murphy, 2012; Perry et al., 2015; Rubinstein-Avila & Lee, 2014; Taube & Jasper, 2009). Math teachers say they lack implementation tools to support ELs (Lopes-Murphy, 2012; Perry et al., 2015; Rubinstein-Avila & Lee, 2014). Various factors affect teacher implementation of accommodations. I proposed that these factors can be identified as predisposing, reinforcing, and enabling based on the Precede-Proceed Planning Model developed by Green and Kreuter (Crosby & Noar, 2011; Green & Kreuter, 1999). My proposed study bridged research and implementation through survey, observation, and interviews.

Increasing Accountability and Assessment

Since the passage of the No Child Left Behind (NCLB) Act (2001), schools have been required to include ELs in annual state testing. Prior to its passage, ELs were often excluded from end-of-year state exams, because of the students' explicit language issues (Kieffer et al., 2009). NCLB required that all students take high accountability exams, which highlighted the academic language difficulties of ELs. Starting in 2015, students in California, including ELs, have taken the Smarter Balanced Assessment Consortium (SBAC) tests that are based on the Common Core State Standards (2010) for English Language Arts (ELA)/Literacy and Mathematics. The SBAC tests replaced the California State Standards test. Students are assessed in ELA/Literacy and Math in 3rd – 8th grades and 11th grade (Smarter Balanced Assessment Consortium, 2017). EL students

who have been in the country longer than 12 months do not receive specific language accommodations on the exam such as simplified syntax, but these students have access to universal tools and designated supports, such as a glossary.

In the last three years of implementation, Math scores for ELs on the SBAC have been lower than their non-EL peers. In the first administration of the SBAC in 2015, 23.3% of Los Angeles Unified School District (LAUSD) 6th through 8th grade students and 20% of 11th grade students were deemed proficient in math ("standard met" or "standard exceeded"). In contrast, only 1% of 6-8th grade ELs and 2% of 11th grade EL math students were deemed proficient. The disparity continues in 2017, where 27.8% of all middle school math students and 23.9% of all 11th grade math students scored standard met or exceeded, while about 2% of ELs scored standard met or exceeded in both middle school and 11th grade (California Department of Education, 2017). The SBAC tests do not provide extra support for ELs unless they are new to the country, so teachers are accountable for implementing reading comprehension strategies during their instruction. Students can practice these strategies in class, on their in-class assessments, and independently on state wide high-stakes exams (Clark-Gareca, 2016). However, the SBAC results show, EL students continue to perform poorly. Though one exam cannot fully capture students' understanding of everything they have learned, it is an indicator that ELs struggle in performance in mathematics.

ELs Struggle with Math Language

Mathematics teachers have difficulty explicitly teaching the language of mathematics to all their students. These teachers often do not see the language of their discipline as something to be explicitly taught. However, to comprehend a problem, students need to create meaning from different semiotic systems: words, symbols, and visuals (Schleppegrell, 2007; Usiskin, 1996).

Word problems are densely packed with meaning that is not elaborated upon. The syntax used in math problems, including comparatives like "Diane makes seven times as much as John," is complex for ELs (Chamot, 2009; Kieffer et al., 2009). Further, the meaning of technical vocabulary can be confusing—especially when there is another meaning of the word in English. For instance, the word "factors" has a particular meaning in a math context. In general English usage, factors are elements that affect an outcome. In math, factors are numbers or expressions whose product is another number or expression. Students only encounter the language of mathematics in the classroom. As a consequence, teachers are the sole instrument of exposure, which puts the responsibility on them to teach this language, not just the content. Therefore, teachers need to explicitly teach ELs the language of math.

They also need to be aware of the theories of second language acquisition so they are able to teach in a way that will develop students' language ability. Krashen's seminal theory of "input plus 1" or the formula $i + 1$, indicates that, for second language acquisition, the language level used in the classroom should be slightly above the language ability of the student (Krashen, 1982). This is similar to Vygotsky's (1962) zone of proximal development that true learning happens slightly above a student's current level. Vygotsky explained that the use of scaffolds, strategies that support students but then are taken away as the student becomes more independent, helps students construct new knowledge (Vygotsky, 1962). Using Krashen's theory as a key theoretical frame, my study investigated the extent to which teachers apply Krashen's theory as they differentiate instruction for the different language needs of their ELs. Using Vygotsky's theory of scaffolding, my study will also investigate how teachers' use of strategies change over time as students' abilities grow.

Existing Interventions and Rationale

Teachers must teach using "scaffolding" to support ELs as the students build their own abilities for reading comprehension. Just as physical scaffolding is needed during construction of a building, instructional scaffolds are temporary and create a path for students to wrestle with and master cognitively challenging math concepts (Vygotsky, 1976; Gersten & Jimenez, 1998; Gibbons, 2009; Walqui & Van Lier, 2010; Coggins, 2014). Examples of scaffolding in math include graphic organizers, models, chunking, peer tutoring, activating prior knowledge, and sentence frames (Coggins 2014; Gibbons, 2009). This study investigated the extent to which teachers apply these scaffolds in their classroom.

Math teachers are exposed to language scaffolds in their pre-service programs but struggle to implement them in their own classrooms. Many cite the lack of time to design and incorporate scaffolds into their lessons and lack of understanding of which scaffold is necessary as barriers to implementing EL supports in their classrooms (Lopes-Murphy, 2012; Perry et al., 2015). In California, teachers use Specially Designed Academic Instruction in English (SDAIE) and English Language Development (ELD) standards to help guide the instruction they give to ELs (California Department of Education, 2015; English Learner Support Division, 2012). SDAIE strategies focus on the use of manipulatives, graphic organizers, and grouping. Math teachers struggle in adapting these supports to their curriculum (Gandara & Contreras, 2009; Perry et al., 2015). Part of the comprehensive approach California is implementing to support ELs is delineating protected time focused on ELD standards called Designated ELD, and Integrated ELD, where ELD standards are addressed in tandem to the content standards. Math teachers with EL students are therefore responsible for incorporating the ELD standards as well as the Common Core Mathematics Standards (CCMS), because their courses are Integrated ELD time (English Learner Support

Division, 2012; Lagunoff, 2015). In California, teachers also use the Sheltered Instruction Observation Protocol (SIOP), which is an observation instrument, paired with sheltered instruction strategies that work to make academic content more approachable for ELs. In the SIOP model, teachers prepare lessons with content goals and language goals. However, during a high-stakes assessment, students cannot get the interactive support they would get from a SDAIE or SIOP lesson. Teachers whose students do well on these high-stakes exams have to slowly remove their scaffolding supports over time so EL students can independently do well. My study investigated the factors that affect teacher implementation of EL strategies and how they learned these strategies.

Teachers need to give EL students the tools to decode a math specific text, to make sense of it, and to solve it. Abedi's research has shown that lowering the linguistic complexity of math texts has improved math scores for middle students (Abedi, 2006; Abedi & Gandara, 2006; Abedi et al., 1998). When language is not a barrier, ELs can achieve at the same level as non-ELs. For the SBAC, teachers cannot control the language complexity on the test, but they can give students the skills to tackle the text using the universal support of text annotation. Therefore, teachers need to build EL students' abilities to annotate text, to uncover the meaning in the complex text, especially with common syntactic phrases such as comparatives, that confound math ELs (Shaftel, Belton-Kocher, Glasnapp, & Poggio, 2006).

Teachers can build strategic readers through four meta-cognitive components: predicting, clarifying, questioning, and checking for comprehension (Draper, 2002; Palinscar & Brown, 1984). Teachers can do so by explicitly teaching these strategies through discourse. Facilitating academic discourse is an important tool in building understanding in a math classroom (National

Council of Teachers of Mathematics, 2014). This study will look at how teachers are explicitly teaching academic discourse.

The Project

This was a mixed methods research study in a low-income urban secondary school district in the Los Angeles area. I surveyed middle and high school teachers to learn what supports or hinders their implementation of EL strategies and what strategies they find to be helpful. I then focused on seven mathematics teachers across the district to observe their classroom practice and interviewed them about their practice. This study's goal was to help the district and schools better support their math teachers who work with ELs by leveraging the factors that affect implementation and help them learn how EL strategies are currently used. The study addressed the following research questions:

1. To what extent do math teachers engage in implementing research-based language development strategies to support their EL students?
    a. What percentage of teachers utilize these strategies?
    b. How often do teachers implement these strategies?
2. How do secondary math teachers apply EL research-based language development strategies in their classroom?
    a. In what ways did teachers implement the research-based language development strategies?
    b. In what ways has research influenced the strategies these teachers use?
    c. What help do teachers need in order to better support ELs?

3. To what extent are math teachers' attitudes towards ELs, as well as beliefs, knowledge, skills, experience, environment, resources, potential for recognition, etc., associated with their implementation of EL research-based language development strategies?

Research Design

In order to answer the questions above, I planned to conduct a mixed-methods study that included an administration of a questionnaire concerning teacher practices, as well as in-depth observation and interviews. Mixed methods research was the best choice for my design as I sought to study the district as a whole and then zoom in to a few classrooms to gain knowledge about specific teachers' process in supporting ELs (Maxwell, 2012; Merriam, 2009). The quantitative part of my study helped answer all three of the research questions, allowing me to learn what strategies are being used and what may drive the teachers' behavior in implementation. The qualitative part most directly addresses the second research question but provides additional insights concerning the other two questions.

Data Collection & Analysis

I collected data through survey, observations, and interviews of participants. First, I distributed an online survey to 135 teachers at 21 schools (nine middle schools and twelve high schools) from a medium-sized district in Southern California. Responses were received from 39 of the 135 teachers contacted (29%). I conducted follow-up classroom observations and interviews with seven of the participating teachers.

I reported descriptive statistics for the survey responses, including summaries of response frequencies and associations between use of strategies and background characteristics. I observed each of the seven teachers during one class period in classrooms that include an EL population of at least 20%. I paid attention to the language the teacher uses with the EL population and the

students' language with each other. Interviews provided insights concerning what helps teachers implement EL strategies in their classrooms.

Site Selection

The site for this study is a charter district in Southern California. The students served by this district are predominately Latino (82%). Approximately 25% are classified as ELs, and 94% are eligible for free or reduced-price lunch. One hundred thirty-five math teachers work at the nine middle schools and twelve high schools in the district. The district's EL population size mirrors that of all California schools where one in four students are ELs (Beal, Adams, & Cohen, 2010; Gandara & Contreras, 2009; Gandara et al., 2003).

Public Engagement and Significance

The findings of this study will be shared with the math curriculum team at the district level. The findings can be used to help the district develop a plan to support math teachers with the factors that influence their application of EL strategies, be it through increasing teachers' knowledge of effective strategies, providing reward structures for implementing EL strategies, or creating an environment within the schools where teachers can feel they can plan for their own success.

CHAPTER TWO: LITERATURE REVIEW

Introduction

Mathematics teachers struggle with meeting the needs of their ELs. These students consistently perform lower on average than other students on national and statewide assessments. Despite various research-based inclusion strategies designed to support ELs in mainstream classrooms and the state requirement in California for teachers of ELs to gain the Bilingual, Cross Cultural, Language and Academic Development (BCLAD) certification, teachers feel unequipped with teaching language in their math classrooms and overwhelmed with finding time to prepare for differentiated language instruction for ELs in their lessons.

This chapter first explores the language difficulties ELs face in mathematics, particular with vocabulary and syntax that halt comprehension (Math Language). In the next section (Language Effects on High Stakes Exams**)**, I present how EL strategies need to be blended into lessons so ELs can get support with vocabulary and syntax while continuing to access more advanced mathematical concepts. I will explain how the elements of Second Language Acquisition through the work of Vygotsky (1962) and Krashen (1982). I will then investigate the history of the low performance of ELs on high stakes exams (EL Math Scores). Then, I will look at why teachers say supporting ELs difficult (Teacher's Struggle). Finally, the chapter will conclude with the use of the Precede-Proceed Planning Model as a framework to organize the hypotheses about the possible influences on the teacher behavior of implementing strategies to support ELs (Possible Influences on Teacher Behavior).

Math Language

The language of mathematics has its own vocabulary, usage, and syntax. To decipher a word problem, students often must decode the interplay of symbols, visuals, and complex

sentences (Abedi, 2006; Kieffer et al., 2009; Schleppegrell, 2007; Usiskin, 1996). The Common Core State Standards in mathematics emphasize the use of language through eight mathematical practices that require students to construct arguments, critique reasoning, justify their work, and attend to the precision of language (Common Core State Standards Initiative, 2015). The language demands of mathematics are substantial. As a result, ELs have tended to struggle on math assessments administered in English.

For students in states using the SBAC math tests, CCSS math standards are assessed through a variety of test items and an extended performance task. A sample performance task for the eleventh grade test illustrates the complexity. Students are required to compare speeding ticket rates in Massachusetts and New York by interpreting a table, creating equations to represent the data, plotting the data, creating a line of best fit, performing a linear regression to create the equation of the line, and using this information to conclude which speeding ticket rate is fairer (American Institutes for Research, 2013). The problem does not use the common term "speeding ticket," but instead the term "speeding fines." The question asks whether the Massachusetts system is "fairer" than the current New York model. The answer is that the Massachusetts system is fairer because the fine increases in increments depending on the amount over the speed limit; however, in a non-math context "fair" is subjective.

In my own administration of this sample performance task, I observed that many students used the subjective meaning of the term. They felt that it was "fair" to charge law breakers large amounts of money because it was "wrong" to speed. They did not understand the definition of "fair" in this mathematical context, so they missed the culmination of the whole activity. There were few written explanations and visual aids for each problem to help EL students understand what each part was asking. Teachers need to be aware of these terms with secondary meanings

like “fair,” so they can explicitly teach their students how to understand the math language they may encounter.

Furthermore, students did not understand how to write a justification using their prior solutions as evidence. Their justification only had to be two sentences, but those two sentences needed to be full of mathematical meaning. In other subjects, justifications are usually longer and more subjective; in math, the evidence gathered only gives one solution, and evidence can consist of numbers or equations.

In order to participate in math classrooms, students have to read various math text such as equations, diagrams, graphs, and written descriptions of problem solving and should be able to reach conclusions from them (Siebert & Hendrickson, 2010; Moschkovich, 2012). A math text differs from texts in other courses because there are more concepts embedded in each sentence than in texts in other content area (Metsisto, 2005; Friedland et al, 2011; Phillips et al, 2009). Instead of synthesizing a narrative to understand the main idea, students have to draw out the meaning from a compact, concept-rich math equation (Fuentes, 1998). For instance, this word problem—“What is the maximum height of a shotput thrown from a height of five feet and initial velocity of 20 ft./second?”—translates to “Find the y-value of the vertex of the equation, $y = -16t^2 + 20t + 5$.” Students would have to draw out the meaning of the initial height and velocity into the equation of the shotput, then understand how to solve for the maximum height using the vertex. In both versions of the problem, there is heavy meaning in each part of the question.

Not only are word problems concept-rich, but they involve different language systems. Word problems are filled with information that draws on different semiotic systems to help students construct knowledge (Schleppegrell, 2007; Usiskin, 1996). Word problems demand that students understand symbols, written language, visual representations, and how these work

together. All of this makes math problems even more difficult for ELs to understand. Teachers have to help guide their students to understanding how these language systems work together.

Language is a deciding factor in whether an EL will do well on a math problem. For students with the same math ability level but different language abilities, the ELs will perform worse on word problems (Abedi, 2006; Abedi & Gandara, 2006; Abedi et al., 1998; Martiniello, 2008). In her study, Martiniello analyzed the linguistic complexity of the fourth grade Massachusetts Comprehensive Assessment System (MCAS) exam, with a focus on Spanish speaking ELs (Martiniello, 2008). The researcher used an analysis of differential item functioning, which involves an examination of differences in difficulty of specific MCAS problems across two groups (in this case ELs and non-ELs), controlling for differences in math proficiency. Word problems with complex syntax such as multiple clauses, long-noun phrases, and connections between phrases that are not apparent had the largest differentials. For example, one word problem asks the following: "To win a game, Tamika must spin an even number on a spinner identical to the one below. [image of a spinner] Are Tamika's chances of spinning an even number, certain, likely, unlikely, or impossible?" This problem has multiple clauses and can be hard to understand for ELs (Martiniello, 2009). Vocabulary also created performance differentials for polysemous words, math-content specific words, and words that have meaning in the dominant culture (Martiniello, 2008). Math problems' syntax and vocabulary act as a hurdle to EL's comprehension of a problem.

Research indicates that when reading a word problem, not knowing a word or concept could halt the entire process of comprehension. Each element of the word problem is important to understanding the whole problem (Chamot, 2009). The syntax relays specific meaning in a problem (Chamot, 2009; Usiskin, 1996). Even as small a syntactic element as a preposition can

derail comprehension. For instance, “4 divided by 2” or “2 divided into 4” mean the same thing. “By” and “into” have explicit meanings in a mathematical context. When translating a sentence into a math expression, some words imply a reverse relationship rather than the seemingly linear one. “The number of ounces of pineapple juice is six less than the ounces of grape juice,” should be written as p = g - 6, while following the sentence in a linear fashion would lead to ELs writing p= 6-g. Further, logical connectors and conjunctions such as “if”, “when”, “therefore”, and “given” have precise meanings. For example, “If given the dependent variable of a linear function, then find an approximation of the independent variable using a table.” The difficulty for ELs is understanding the precise inherent meanings in these logical connectors and conjunctions. For the above example, the first clause is assumed to be true for the problem and gives information that is important to the solving of the second part; without understanding the connection between “if/then” statements the students’ comprehension is halted. Teachers overestimate their students’ ability to understand these transition words. Students need to be expressly taught how to decipher math sentences, so they can comprehend what the questions are asking.

Language Effects on High Stakes Exams

Direct empirical analysis of vocabulary and syntax as a source of difficulty for ELs focuses on high stakes exams. When ELs were given language supports on their math exams, they did better (Abedi & Gandara, 2006). Using dictionaries to support vocabulary difficulty has been shown to be the most effective math test accommodation. In their meta-analysis of studies on accommodations, Kieffer, Lesaux, Rivera, and Francis (2009) found that English language dictionaries and glossaries were the only accommodations that positively affected ELs’ performance on assessments. The high-stakes exams investigated were math, reading, and science tests in fourth, fifth, sixth, and eighth grades. For eighth grade math tests, the use of dictionaries

and glossaries helped reduce the achievement gap by about 11% (Kieffer et al., 2009). Vocabulary is a key roadblock for comprehension for ELs. The use of native language did not help because it was not the language used in class for instruction (Abedi, 2006; Kieffer et al., 2009; Kopriva et al., 2007). Kiefer et al. (2009) hypothesize that classroom teachers do not support the academic English skills of ELs, that there is no "language-free" content, and that the nature of being ELs means students have less opportunity to access high level content

Despite the research that shows that vocabulary and syntax are the key issues ELs face, many teachers do not implement supports for language on their assessments. Clark-Gareca's study (2016) looks into the supports math and science teachers provide on their formative and summative assessments. The researcher found that teachers rarely used dictionaries for supports and mostly relied on extra time on exams as a support for their ELs (Clark-Gareca, 2016). Teachers in the study did change their support based on the teachers' perceived belief in their students' abilities. However, the teachers did not focus on the specific language issues the students faced.

Modifying the language used on math exams has also helped to alleviate the language burden on ELs so they can problem solve at a higher level. Abedi, Lord, and Hofstetter (1998) created three different versions of an eighth grade math test: one in original English, one in linguistically modified English, and one in Spanish. These tests were given to 1,394 Southern California students. The students who used the linguistically modified English version of the math exam improved their performance by 49% (Abedi et al., 1998). However, the use of linguistically modified English is not always used due to concerns about the reliability and validity of the assessments (Abedi, 2006). Abedi and Lord (2001) continued to investigate linguistically modified exams in another study of 1,031 eighth grade ELs and non-ELs in LAUSD. The syntax of a NAEP mathematics test was simplified, but the math vocabulary was unchanged. ELs showed

significant improvement on this exam, as did struggling–to-average non-ELs. This result raises a question regarding the validity of these changes, because the changes to the questions are intended to only support the language needs of ELs, not the content needs of struggling learners (Abedi & Lord, 2001).

Research shows vocabulary and syntax plays a key role in language difficulty for secondary students, in particular. Shaftel, Belton-Kocher, Glasnapp, and Poggio (2006) conducted a study of the linguistic difficulties in word problems for fourth, seventh, and tenth grade students on the Kansas general math assessment. The study looked at the results of 8,000 students with the EL population varying from 905 in the fourth grade to 328 in the tenth grade (Shaftel et al., 2006). As the grade level increased, different linguistic issues arose for the students. For fourth graders, prepositions, ambiguous words, complex verbs, pronouns and math vocabulary had negative effects on the performance of ELs. For tenth graders, the issues were more focused, and math vocabulary and comparatives affected students' scores the most (Shaftel et al., 2006). Math language often uses a comparative structure; for example, "5 is greater than -2" and "-2 is less than 5" mean the same thing. This language structure is confusing for ELs (Chamot, 2009; Shaftel et al., 2006; Usiskin, 1996). Support that a secondary student needs would be different from what an elementary school student needs. I investigated secondary teachers' practice and how they addressed the vocabulary and syntax at their grade level.

EL Language Strategies

To support ELs' academic language skills, teachers must explicitly teach vocabulary and syntactic structures in their classrooms, while teaching content. Math is a foreign language that students learn exclusively at school. Thus, while teaching the concepts, teachers need to teach the language as well (Adoniou & Qing, 2014; Chamot, 2009; Cirillo et al., 2010; Tan, 2011; Thomson

& Rubenstein, October 2014; Usiskin, 1996). Rather than making instruction about low language abilities, math ideas should be mixed with language development (Moschkovich, Dec 2015). It is the teachers' responsibility to build ELs' language skills and encourage communication and discourse in their classrooms (Heritage, Walqui, & Linquanti, 2015; Moschkovich, May 2015). In my study, I investigated how teachers incorporate their language strategies for ELs in their lessons.

The Common Core State Standards say that "language is a resource for learning mathematics" (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2015, p. 2) Teachers need to develop discourse to help students with the productive struggle of understanding math concepts (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). Students need to be taught in a cognitively demanding way, but also have language supports to access the material (Cummins, 2000). When math is taught in a student-centered rigorous way, ELs gain mathematical skills as well as English language skills (Heller, Hanson, Barnett-Clarke, & Darling, 2010). ELs need individualized accommodations that are practiced during classroom instruction. The accommodations provided should mirror those given on high-stakes exams, so students can utilize the supports well. I looked to see how teachers applied this in practice.

Academic discourse builds students' critical thinking skills and puts the cognitive load on the student rather than the teacher. Facilitating student language use has a new focus in the Common Core State Standards in Mathematics through math practice number six, the precise use of the language of mathematics (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). It's the teachers' responsibility to build ELs' language skills and encourage communication and discourse in their classrooms (Heritage et al., 2015). Participating in a mathematical discussion and attentive listening helps students gain a

deeper understanding of what is taught (Bailey, Blackstock-Bernstein, & Heritage, 2015; Kinsella, 2016; Moschkovich, 2012; National Council of Teachers of Mathematics, 2014).

In California, educators need to earn a BCLAD certification to be able to teach ELs. This shows that they understand Specifically Designed Academic Instruction Delivered in English (SDAIE) strategies and give instruction for English Language development. There are many strategies introduced to teachers in their education programs. In this study, I focus on five: Sentence Starters, Structured Engagement, Think Aloud, Reciprocal Teaching, and Vocabulary Instruction.

Sentence Starters

Sentence starters give ELs the tools to increase the quality and quantity of their communication, both verbally and in writing. The teacher provides students with a sentence that the student has to finish such as, "The solution is _____, because _____" This way the student understands the role of syntax and vocabulary (Carr et al., 2009; Kinsella, 2013; Phillips, Bardsley, Bach, & Gibb-Brown, Spring 2009). The teacher can be more specific and provide the parts of speech the student needs to use in each blank. They can also provide precise word bank with the verbs, adjectives, and nouns that will ensure students are working with the appropriate vocabulary and this bank is developing language skills (Kinsella, 2013, Oct 2012). The teachers are explicitly teaching how to use math language syntax and vocabulary when they provide students with sentence starters.

Structured Engagement

A valuable strategy to increase discussion and give ELs the chance to use the language of mathematics in class is Structured Engagement. To implement this strategy, the teacher structures the conversation between students. The most common example of structured engagement is

Think-Pair-Share. Students get time to think over a question, then turn to their partner and share their answers. The teacher can then call on students and know that they had a chance to formulate the answer and practice with another student (Carr et al., 2009; Lyman, 1981). This helps ELs to prepare their answer before sharing to the whole class and lower their affective filter. Instead of the most vocal students answering a question before everyone has a chance to think about it, every student gets to engage in discussion with a partner (Lyman, 1981). The structure allows for structured wait time for the students to think and formulate a response (McTighe & Lyman, 1988). It also gives students the chance to practice using the academic language in the classroom, which is so important for ELs. To support the language even more, teachers can include sentence starters to help the student formulate what they will say (Kinsella, 2013). The teacher can vary the difficulty of the problem based on the questions they pose to the class. When it comes to problem solving, think-pair-shares help build students' abilities to solve problems (Cortright, Collins, & DiCarlo, 2005). Think-pair-shares allow EL students to engage in answering questions. The main limitation is that this is a brief activity. It does not stimulate powerful discussions between students that make students' probe into deeper thinking without adding more to the basic discussion frame (Zwiers & Crawford, 2009).

Think Aloud

A teacher uses Think Aloud to model his or her thinking while approaching a problem. The teacher could use this strategy in conjunction with notes, so students write down the steps to solving or something to be careful of as they solve a particular problem (Carr et al., 2009). The teacher is modeling how they are thinking through the problem, which in turn helps students understand how they should be thinking as they read through problems (Davey, 1983). ELs get to

see how the mathematical language is used for these problems, and the teacher will have them practice the think aloud strategy so they can also use the language productively in class.

Reciprocal Teaching

Reciprocal teaching strategy is an effective way to build students' reading comprehension. The teacher engages students in a conversation to create a shared understanding of the text through the metacognitive strategies of predicting, questioning, clarification, and summarizing (Ahmadi & Gilakjani, 2012; Meyer, 2014; Palinscar & Brown, 1984). The interactive process helps students build their confidence and improve their reading comprehension, so they can eventually use these tools of comprehension on their own. The students work in small groups using structured dialogue to guide discussion. Graphic organizers and sentence starters can help support ELs through the dialogue (Carr et al., 2009). The teacher models the metacognitive strategies through a section of text or a word problem, and then the students practice the strategies in roles as teacher and student(s) (Palinscar & Brown, 1984). This allows for students to build their skills with these metacognitive strategies that are important in mathematical thinking.

Vocabulary Instruction

Specifically teaching vocabulary and providing vocabulary support is another way to build EL's language ability (Beck, McKeown, & Kucan, 2013; Graves, 2007; Marzano, 2004). Teachers can do this in many ways, one of which is to use graphic organizers to help students create a visual representation to make connections between new concepts. Students visually organize their new learning, so it is easier for them to access the material (Zollman, 2009). They also helps students organize their thoughts and support their thinking as they work on a larger task like solving a word problem or synthesizing their solution to a problem (Carr et al., 2009; Cirillo et al., 2010). Graphic organizers can take many forms like a Venn diagram for comparing information (Forsten, 2010;

Phillips et al., Spring 2009). The teacher amplifies the vocabulary in a lesson and provides ways for students to practice using the word.

These strategies give language supports to students so they can communicate in math class and access the content. In my study, I looked to see which of these strategies teachers say are the most helpful for them to implement and how they have found ways to implement them in their daily practice. In 2017, research out of the Stanford Graduate School of Education formulated math language routines to support math teachers in their classrooms. These routines are "structured but adaptable format for amplifying, assessing, and developing students' language", in a math classroom (Zweirs, 2017, p. 9). The routines have not been widely introduced to the teachers in the district that was studied, but contain elements of the strategies listed below as seen in Appendix A. In Appendix A provides a crosswalk between the five strategies considered in this study and the Math Language Routines from Zweirs (2017).

Second Language Acquisition Theory

I used the theories of Lev Vygotsky and Stephen Krashen to understand how ELs are learning in their classrooms. Vygotsky (1962) shows that students' learning occurs in the "zone of proximal development" where they can create meaning and build knowledge from the social interactions in their classrooms. The teacher is not the direct source of knowledge, but facilitates learning for everyone in the classroom; the teacher, in turn, also learns. Ideas are generated from the collective—not just the expert in the room (Lambert, 2002; Larochelle, Bednarz, & Garrison, 1998; Vygotsky, 1962). The environment in the classroom and the learning experiences within are how students construct meaning (Dewey, 1938/1997; Draper, 2002; Larochelle et al., 1998). The teacher uses temporary scaffolds to grasp new knowledge. ELs need language scaffolds that are removed over time for them to access the math content the teacher is sharing.

Krashen's Input Hypothesis is similar to Vygotsky's zone of proximal development, but focuses on language development. It states that when acquiring a second language, students understand language that contains language structures slightly above what the student already understands (Krashen, 1982). Krashen explains this as moving from stage *i*, which represents the current level of competence, to *i*+1. The students understand the meaning of what is being communicated when the language used is slightly above their ability level. Teachers should reduce the linguistic complexity of what they say in the classroom to a level that is a little beyond the ability of their EL students, but also ensure that they are still allowing students to understand the content they are teaching (Krashen, 1982). The teacher must differentiate his/her supports so it is meeting the linguistic needs of his/her students. California currently categorizes ELs into three levels of English language development: emerging, expanding, bridging. For each level, there are ELD standards that help clarify for teachers how to address their students' needs (English Learner Support Division, 2012). The proficiency levels represent ranges in an underlying continuum, where students' ability to use complex language increases as they progress in levels. My study investigated how teachers use Krashen's *i*+1 theory to differentiate instruction and how the students' language proficiency level affects this differentiation.

EL Math Scores

The goal of English Language Development (ELD) instruction is for students to be re-designated as English Proficient; however, it takes about five to seven years for ELs to catch up to native English speakers (Abedi & Gandara, 2006; Cummins, 2000; Gibbons, 2009). The expression often used to describe the difficulty of being an EL is that they have to catch up to a "moving target," because the language and content in school continues to increase in complexity the longer ELs are in school (Cummins, 2000). In a 2006 study, researchers found the probability

of an EL in a California school being re-designated to English Proficient after ten years to be less than 40% (Parrish et al., 2006). The California Together Survey (2010) found that one third of ELs in secondary schools in California are long-term ELs (LTELs), students who have been in the state for six or more years and have not re-designated as English proficient. These students are high functioning in social language but weak in academic language (Olsen, 2010). There is pressure for all teachers to support ELs on re-designating, so language will no longer act as a barrier to their academic growth.

Prior to the 1990s and the passage of the NCLB Act (2001), ELs were often excluded from high stakes national or statewide assessments, because researchers thought the results would be invalid (Kieffer et al., 2009; Kopriva et al., 2007). However, NCLB required that ELs be included in assessments. This policy has highlighted the struggles ELs have in school. According to the *Independent Evaluation of the California High School Exit Examination (CAHSEE): 2013 Evaluation Report*, 83% of all students passed the CAHSEE on their first try (Becker, Wise, Hardoin, & Watters, 2013), but only 54% of the ELs passed on the first try. By the end of junior year, the passage rate of all students in the state was about 85%; for ELs, it was only 56% (Becker et al, 2013). On the current statewide SBAC tests, EL and non-ELs show great differences in scoring proficient (standard met or standard exceeded). For the 2017 Math SBAC administration in LAUSD, 2% of ELs in 6-8th and 11th grade met or exceeded standards and approximately 30% of non-EL students met or exceeded standards (California Department of Education, 2017). These test scores show the struggle EL students face and their continued need for targeted support from their math teachers.

Teachers' Struggle

Researchers like Jamal Abedi recommend the use of accommodations or scaffolds, a resource students use during math instruction or a math assessment that allows students complete the same classroom activity or assessment as other students but changes the formatting, environment, or timing (Abedi, 2006; Abedi & Lord, 2001; Abedi et al., 1998; Kieffer et al., 2009). Accommodations to assessments and test instructions provide students with a different path to how they learn or are assessed but does not change what students learn, so they have an equal opportunity to demonstrate their knowledge of the content. Various strategies help provide accommodations and scaffolds for students.

Teachers say they are not prepared to work with EL populations and are not sure of their ability to support ELs well in their classrooms. Self-efficacy in this context means a teacher's belief in his or her own ability to accomplish a task (Woolfolk Hoy & Davis, 2006). Secondary-education teachers do not feel they have enough training to work with ELs (Lopes-Murphy, 2012; Rubinstein-Avila & Lee, 2014). In my study, I gained an understanding of these factors that influence teachers' feelings about working with ELs.

Ross (2014) explored how math teachers felt a reduction in self-efficacy when working with ELs. Using a survey administered to 400 mathematics teachers, Ross found that teachers of ELs felt they had lower self-efficacy than teachers of non-EL students. Years of experience teaching did not affect the self-efficacy of teachers of ELs (Ross, 2014). The researcher also investigated how professional development (PD) impacted these 400 math teachers. There is a positive correlation between teachers' participation in EL focused PD and self-efficacy. However, Ross found that, though many PDs were offered in the district serving these teachers, only 45.6% of teachers participated in them (Ross, 2014). Those that did participate most often went to one-

time workshops, which are considered the least effective type of professional development (Bell, Wilson, Higgins, & McCoach, 2010; Ross, 2014). In my study, I saw how teachers learn to support ELs and find ways to include strategies to support ELs in their practice. Other studies have also shown that teachers do not feel they have been prepared enough to support ELs. WestEd conducted a survey of 1,000 K-8 teachers and administrators in eight California school districts with which they were working about their perspectives on implementing the Common Core State Standards (Perry et al., 2015). Of the teachers surveyed, 46% felt they gained little or no support from PD to support ELs and 25% felt they got enough support in PD (Perry et al., 2015). These teachers were not in secondary education, but Rubinstein-Avila and Lee (2014) state that secondary-teachers have largely been ignored in their preparation for supporting ELs compared to K-8 (Rubinstein-Avila & Lee, 2014). Teachers at all levels have stated the need for training on how to support ELs. In a survey of 10,512 California State University teacher credential candidates in the year 2000, about 25% of teachers felt they were not or somewhat prepared to teach English learners (Gandara et al., 2003).

Possible Influences on Teacher Behavior

To help organize hypotheses about the various influences on teacher behaviors related to implementation of strategies to help ELs, I used the Precede-Proceed Planning Model (PPM). Green and Kreuter (1999) developed the PPM as an ecological model of health promotion for planning and evaluating a health intervention.

The PPM can provide a structure to understanding what influences math teacher behavior, where the behavior is implementation of EL strategies. A representation of the PPM is shown in Figure 2.1 (Crosby & Noar, 2011; Green & Kreuter, 1999). This figure shows the basic elements of the model. The model describes three types of factors that affect behavior: predisposing,

reinforcing, and enabling. By predisposing, Green and Kreuter (2005) mean self-efficacy, attitudes, and beliefs that affect one's behavior. In our context, predisposing factors may include a teacher's belief that it is part of their responsibility to support ELs and that it is possible to successfully support ELs during math instruction (in contrast to the belief that, for example, "I'm a math teacher, not a literacy teacher"). The reinforcing factors focus on how the given behavior—in this case implementing EL strategies—can be encouraged (Crosby & Noar, 2011; Green & Kreuter, 1999). It would be important to know whether teachers are gaining praise, rewards, or intrinsic rewards for implementing EL strategies, or if lack of implementation is noticed. Enabling factors include the procedures, skills necessary, and environmental conditions that make it possible to implement this behavior. For math teachers, enabling factors may include knowledge of the various EL strategies, time to plan for implementation, and knowledge of student needs.

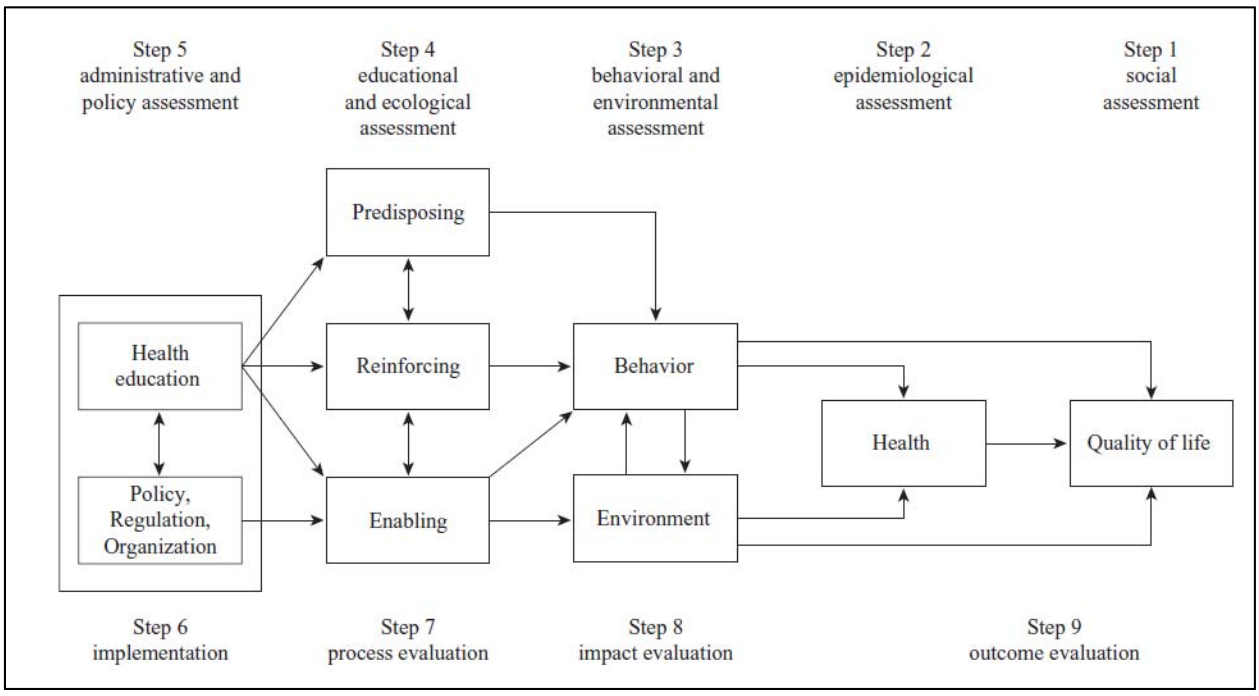

Figure 2.1 Visual depiction of the Precede-Proceed Planning Model (Source: Green and Kreuter, 1999, p. 34).

I first want to confirm that these factors are indeed the key influences on the desired behavior of implementing EL strategies. With that understanding, then one could go about developing interventions to support teachers. I adapted the PPM to organize my hypotheses of influencing factors for middle school and high school teachers' implementation of serving ELs in Figure 2.2. Ultimately, teachers work to support the learning of all students in their classroom, so they have the opportunities to pursue a future of their choice. This is captured in the right two boxes of the model. My hypothesis includes that teachers' practice is what influences EL students' growth and performance. The way math teachers can serve their ELs is through their use of best practice research-based language development strategies.

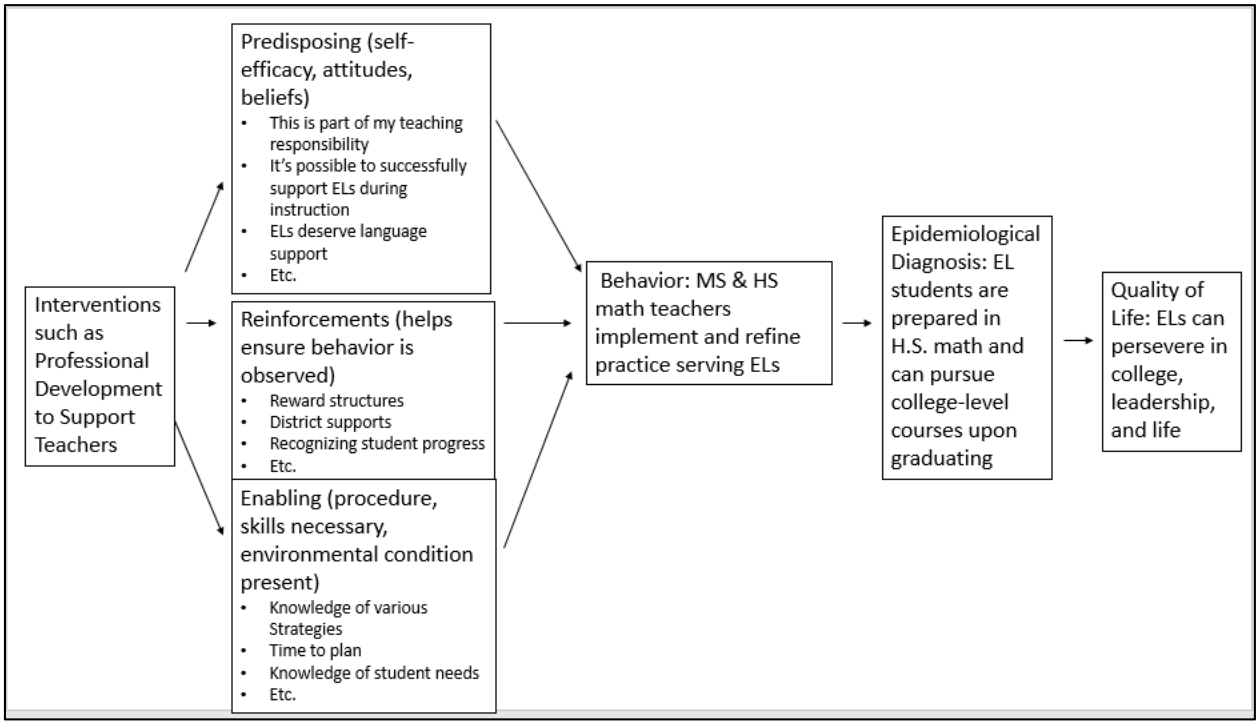

Figure 2.2 Proposed adaptation of the PPM Model in this study's context.

The PPM model is helping me to understand what may influence math teachers' behavior, so I placed these possible predisposing, reinforcing, and enabling factors to the left of the desired behavior from teachers. My hope was that if I got an understanding of these possible factors, then

interventions such a school site professional development could strategically target the factors that may affect teachers' behavior.

Conclusion

Knowing that there is a lot of research about what teachers should do to support ELs is great for mathematics teachers. The challenge is to implement these strategies within actual high school mathematics classrooms. In Los Angeles, low math performance of ELs is a persistent issue, and teachers feel unequipped to meet these students' needs. This study investigated how math teachers have found ways to implement EL strategies and to help develop insights as to how this could become replicable for other teachers.

CHAPTER THREE: RESEARCH DESIGN AND METHODOLOGY

Introduction

This study was an examination of teachers' behaviors related to instruction of ELs. I studied the extent to which, and ways in which, teachers implement strategies to support ELs and examined various factors that may influence those behaviors. This study helps us understand teachers better—what helps them implement and what prevents them from implementing EL strategies. With this understanding, schools and districts could better support their teachers, through strategic interventions. The following research questions were addressed during the study:

1. To what extent do math teachers engage in implementing research-based language development strategies to support their EL students?
    a. What percentage of teachers utilize these strategies?
    b. How often do teachers implement these strategies?
2. How do secondary math teachers apply EL research-based language development strategies in their classroom?
    a. In what ways did teachers implement the research-based language development strategies?
    b. In what ways has research influenced the strategies these teachers use?
    c. What help do teachers need in order to better support ELs?
3. To what extent are math teachers' attitudes towards ELs, as well as beliefs, knowledge, skills, experience, environment, resources, potential for recognition, etc., associated with their implementation of EL research-based language development strategies?

In this chapter, I will discuss the research design, the site, the participants, data collection, analysis, my role management, and ethical issues.

Research Design

To study what factors influence the teachers' behavior and how the teachers' implement EL strategies, I pursued a mixed method research design (Maxwell, 2012). During the course of this project, I distributed an online questionnaire to 135 teachers; 39 teachers responded. Next, I conducted classroom observations and follow-up interviews with seven of the participants. The questionnaire included questions related to the hypothesized influences on teacher behaviors shown in Figure 2.2. The behavior of interest was math teachers' implementation of strategies to support the learning of their EL population. I identified possible influences on this behavior within the categories suggested by the PPM model. I hypothesized that predisposing factors to implementing these EL strategies would include teachers' attitudes and beliefs about supporting ELs language development. I hypothesized that reinforcing factors would include evaluation procedures within the school and district that encourage or discourage the desired behavior. I hypothesized that enabling factors would include knowledge of EL strategies and time to plan implementation (Crosby & Noar, 2011). Following the survey administration, I observed a small number of teachers for one class period. Within this observation, I collected data concerning the teachers' utilization of research-based language development strategies or tool, including dictionaries, sentence starters, think-pair-shares, graphic organizers, think aloud, and reciprocal teaching. After the observation, I also interviewed these teachers in order to learn how they planned for these lessons, how they use theories such as Vygotsky's zone of proximal development and Krashen's input hypothesis, and how they adapt the strategies based on the students' language abilities.

Site and Participants

Site

The site for this study is a charter district in Southern California. The students served by this district are predominately Latino. Approximately 25% are classified as ELs, and 94% are eligible for free or reduced-price lunch. There are twelve high schools and nine middle schools serving 11,000 students. The district's EL population size mirrors that of all California schools where one in four students are ELs (Beal et al., 2010; Gandara & Contreras, 2009; Gandara et al., 2003). This site is appropriate for the study because of the size of its EL population. The district and school's mission is to decrease the achievement gap and to graduate students prepared for college, leadership, and life.

Access

I currently work in this district as a math curriculum specialist and am part of a team that works closely with all the math teachers in the district. Previously, I was a teacher in this district for several years, and I worked closely with other math teachers and department chairs. I understand the structure and culture of the district. I have frequently opened up my classroom to teachers from other schools and have been videotaped several times for instructional purposes for other math teachers. This study was conducted with the support of the district's Director of Math Programs and the Chief Academic Officer.

Selection Criteria

The survey went out to all 135 math teachers in the district. Based on the response rate the math team has received on previous surveys, I expected about 50 teachers to respond. In order to participate in the observation and interview a teacher needed to have a math class that included

ELs, preferably at different proficiency levels. This was necessary in order to gather evidence of how the strategies are adapted for various students.

Participation. The survey was distributed through email to all middle and high school math teachers. To encourage participation, I explained the purposes of the survey, ensured privacy for the teachers by assuring teachers that none of their identifying information would be shared and was secured, described the time commitment, and explained that participation in the study was voluntary and would not affect teachers' evaluation scores. I took three approaches for recruitment for the observation and interview portion: (1) teachers indicated their interest on the survey, (2) I asked the Director of Math Programs in the district to recommend individuals with whom I would then follow-up, and (3) I checked that they taught a class period with at least 20% of the students representing ELs, so I could gather meaningful data. My goal was to have at least five teachers for my study, but of the seventeen teachers who said they were willing to participate, seven met my criteria. I then scheduled times to observe them during the days they would prefer, but during the class periods they had the most ELs. I also asked them whether they would commit to a thirty minute in person interview about their practice at a convenient time for them, preferably right after the observation.

Data Collection

Survey. I sent an online questionnaire to all 135 middle and secondary math teachers in the district. I gave them a three-week window to complete the survey and 39 teachers responded (28.9%). The survey focuses on the first and third research questions. I looked for predisposing, reinforcement factors, and enabling factors that influence teachers' behavior in supporting the EL in their class that helped me answer research question 3. The survey is provided in Appendix B.

Observations. I observed each teacher's full lesson, which ranged from 35 to 110 minutes, depending on the school site. These observations helped answer the second research question. I looked for evidence of implementation of language strategies including dictionaries, sentence starters, think-pair-shares, graphic organizers, think aloud, and reciprocal teaching in the teachers' classroom that support students' math language. I looked for when the strategies seem to be used to push the students' language abilities that could be explained with Vygotsky's zone of proximal development and Krashen's $i+1$. When such interactions were observed, I followed-up during the interview to gain clarification about his/her thought process when he/she adapted the language strategy at these times of the lesson. In particular, I looked for how students use language supports while discussing problems with their teachers and then whether and how students use the supports when discussing with partners or groups. I took my observation notes on my Observation Protocol document (Appendix C).

Interviews. I also addressed the second research question through a semi-structured interview with each of the participating teachers. The questions were open-ended. The interviews were approximately thirty minutes and followed an interview protocol (provided in Appendix D). I investigated what influences the teacher's choices in which linguistic support to use. I determined how the teachers plan for the use of supports in their lessons. The interviews were recorded with the participant's consent and I transcribed them.

Data analysis methods

I analyzed the survey data based on my adaptation of the PPM (Figure 2.2). The survey questions were broken down based on the main categories: predisposing, reinforcement, and enabling factors and addresses the first and third research questions (see Appendix B and Figure 3.1). I analyzed frequencies and compared responses across behaviors to gain an understanding

how these factors may interplay to explain behavior. Figure 3.1 shows the particular parts of my adapted PPM model I was investigating for research question three. I reported descriptive statistics on the questions from the survey and analyzed correlations between hypothesized influences and teacher behaviors.

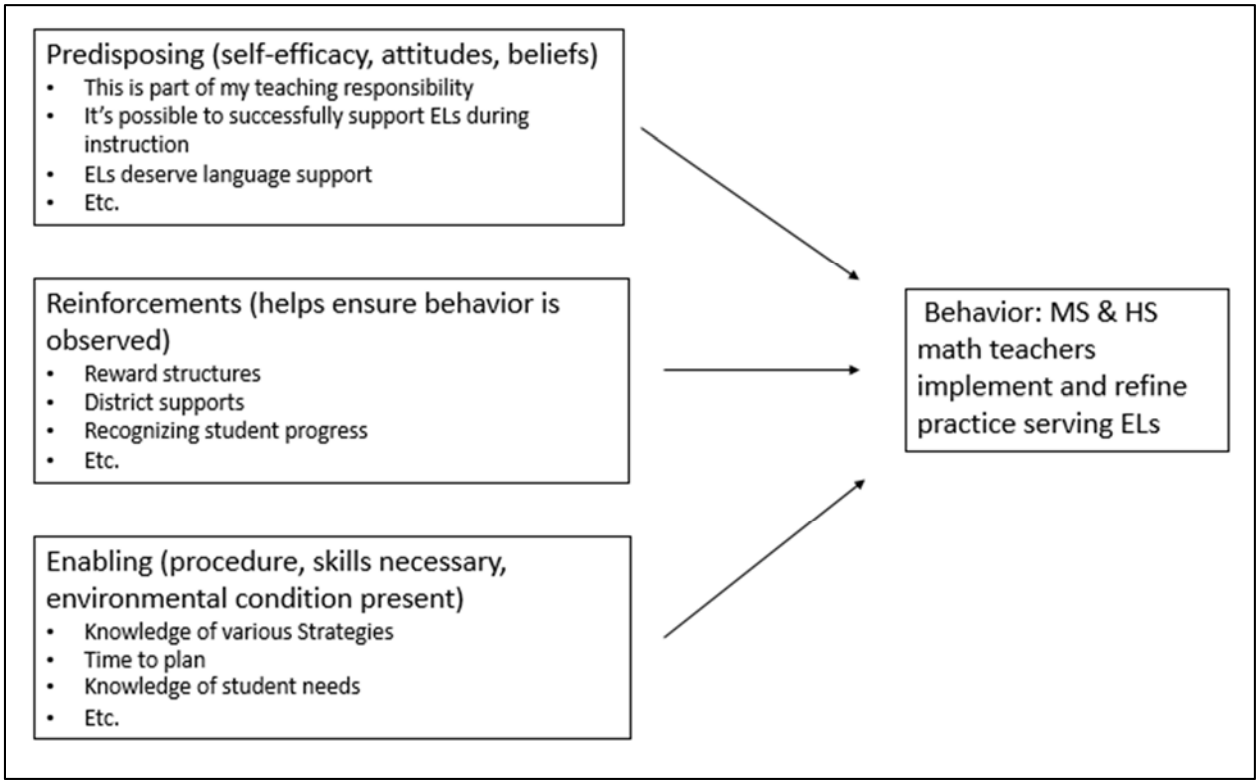

Figure 3.1 Possible factors affecting math teachers' behavior.

I analyzed the observations and interviews to see how they connect. I looked for the teachers' implementation of EL strategies that support students' vocabulary development and supported students in the decoding the math specific syntax. I read each observation over twice and assigned codes to transcript excerpts based on the elements of my research questions: EL strategies used, academic discourse between teacher and student, academic discourse between students, and how the strategies differ between different groups or individual ELs. I analyzed the transcripts of my interview using the same coding from the observations. I looked to see if this

data corresponds to the observation and survey. I placed the evidence into different documents representing the different parts of my research questions. I analyzed the documents from each lesson and color code the parts of the document that align with what was observed in class.

Ethics

I am a math curriculum specialist coach in the district where the study was conducted. Thus, I am a colleague to the potential participants. However, my professional role does not include evaluation of teachers. I ensured that teachers understood that participation was voluntary and that the decision to participate or not would not be shared with others (e.g., school administration). Also, I reported study results in ways that do not identify specific teachers or schools. Given the general recognition of the need to better support ELs across all content areas, there was strong support for this study among the district's math teachers and administrators

I maintained confidentiality throughout my study. I used pseudonyms in my report for the participants and sites. I password protected my data collection files and destroyed the data after the study was completed. Potential research participants were informed of the purposes of the study, and data was only collected from teachers who consented to participate.

Summary

The purpose of this study was to investigate how EL strategies are used in secondary classrooms and what factors influence the teachers' behavior in implementing those strategies. Through the investigation, I gathered data to help counter the difficulties other math teachers face in supporting their ELs. These findings will contribute to the knowledge of the math teachers in the district, so they can all support the ELs in their classrooms.

CHAPTER FOUR: FINDINGS

Introduction

This study used a mixed-methods approach to examine secondary math teachers' implementation of English Learner language development strategies at a small district in which 25% of the students are English Learners (ELs). The first goal of the project was to investigate what EL strategies secondary math teachers used in practice. The second goal was to discover how math teachers implement these strategies in their classroom. The third goal of the project was to gain insight on what may influence teachers' implementation of EL strategies to help us understand why teachers implement some strategies. Math teachers in the district answered a questionnaire to help me gain an understanding of the aspects that may influence behavior; observations and interviews helped flesh out this data to see how strategies are implemented in the classroom. In this chapter, I first describe the study participants. I then present the findings, organized by the three research questions.

Description of Participants

The questionnaire was sent to 135 middle and high school math teachers in the district spanning nine middle schools and 12 high schools. The questionnaire was open for three weeks. During this time, I sent three email reminders and extended an invitation to participate during one district professional development. Of these 135 teachers, 39 responded (29%). The respondents represented eleven of the twelve high schools and five of the nine middle schools. As seen in Table 4.1, the majority of respondents were from high school (77%), while only 60% of the math teachers in the district teach at the high school level. There was a range of years of experience, with most respondents being in their first five years of teaching. Based on the breakdown on all teachers in the district, the 64% of the 135 math teachers are within their first five years of

teaching. The online questionnaire had a similar breakdown of teachers' level of experience, with 67% of the respondents being in their first five years of teaching.

Table 4.1. Description of Sampling Frame and Study Participants.

	Sampling Frame (N=135)		Online Questionnaire (N=39)		Interview/Observation (N=7)	
	N	%	N	%	N	%
Years of teaching experience						
0-2	35	25.9	13	33.3	0	0.0
3-5	51	37.8	13	33.3	3	42.9
6-8	24	17.7	5	12.8	1	14.3
9+	25	18.5	8	20.5	3	42.9
Level						
Middle School	54	40.0	9	23.1	3	42.9
High School	81	60.0	30	76.9	4	57.1

On the questionnaire, I asked if teachers were open to being observed and interviewed. Of the 39 respondents, 17 indicated they would be willing to participate in that follow-up. From those 17 volunteers, I selected seven who met my criteria of having a population of at least 20% ELs in at least one class period and were recommended by the Director of Math Programs. The final group of seven teachers (Table 4.2) spanned seven different schools and represented different grade levels.

Table 4.2. Summary of observation and interview participants (N=7).

Teacher Name (pseudonym)	Years of Experience	Level	Student Grade Level(s)	Course	# ELs in Class	Total # Students	% ELs in Class
Ms. Berger	10+	High School	10	Algebra 2	6	26	23.1
Ms. Cabras	10+	Middle School	8	Grade 8 Math	5	18	27.8
Mr. Calderon	4	High School	11	Algebra 2	12	15	80.0
Ms. Esteban	9	High School	9	Algebra 1	7	28	25.0
Ms. Leiva	6	High School	9-12	Algebra 1	12	30	40.0
Ms. Medrano	3	Middle School	6	Grade 6 Math	7	27	25.9
Ms. Phillips	5	Middle School	7	Grade 7 Math	7	32	21.9

Findings Related to Research Question One

My first research question asks about what strategies teachers are using in their classrooms. The questionnaire asked about the five specific strategies discussed in Chapter 2 and also gave teachers the option to write in the strategies they use in their lessons. Table 4.3 summarizes the reported frequency of implementation for each of the five strategies, as well as correlations between these frequencies. My findings are that Vocabulary Instruction is not used as frequently as the other four strategies and Think Aloud, Structured Engagement, and Sentence Starters are the most frequently used strategies compared to Reciprocal Teaching and Vocabulary Instruction.

Use of Strategies: Online Survey Responses

The five strategies were reported as being use about once every week based on their means. Table 4.3 summarizes this data. We see the frequency as presented in the questionnaire including the mean and standard deviation of frequency of each strategy. The possible relationships between the strategies will be investigated below after an analysis of the frequencies. Teachers indicated that they used sentence starters and structured engagement frequently, with 35.9% saying they use these two strategies every lesson. Sentence starters were used at least once a unit for 84.6% of the respondents and structured engagement was used similarly by 87.1% of the respondents. Sentence Starters also had three teachers respond that they rarely or never use the strategy. Think Aloud had the highest reported frequency of use, with 94.9% of teachers indicated use at least in "every unit" (43.6% indicated using Think Aloud daily). Reciprocal Teaching was also indicated as being used frequently once a week. Vocabulary Instruction is the strategy teachers indicated they used the least frequently. This strategy had a mean frequency that was closer to every unit, rather than every week like the rest of the strategies.

Table 4.3. Reported frequency of teacher implementation of research-based strategies for supporting ELs (N=39).

Strategy	Every Lesson (1)		Every Week (2)		Every Unit (3)		More than Once (4)		Rarely or Never (5)		M	SD	Spearman Correlations				
	N	%	N	%	N	%	N	%	N	%			(a)	(b)	(c)	(d)	(e)
(a) Sentence Starters/Frames	14	35.9	13	33.3	6	15.4	3	7.7	3	7.7	2.18	1.23	1.00				
(b) Structured Engagement	14	35.9	13	33.3	7	17.9	5	12.8	0	0	2.08	1.04	.310	1.00			
(c) Think Aloud	17	43.6	16	41.0	4	10.3	2	5.1	0	0	1.77	2.21	.172	.243	1.00		
(d) Reciprocal Teaching	9	23.1	17	43.6	9	23.1	4	10.3	0	0	2.21	0.92	.045	.215	**.320**	1.00	
(e) Vocabulary Instruction	2	5.3	13	34.2	13	34.2	5	13.2	5	13.2	2.95	1.11	.107	.193	.085	.109	1.00

Notes: correlations with p<.05 shown in bold; correlations with p<.01 shown underlined.

There were also some relationships between the strategies. These associations are based on a small sample size (N=39), and most had p values that were greater than .05. Sentence Starters and Structured Engagement had a positive but not statistically significant association (Spearman's r = .310, p = .055). Teachers who stated that they used Sentence Starters frequently also reported that they used Structured Engagement frequently. Sentence Starters was a strategy teachers indicated they used frequently and had a positive but non-significant association with Think Aloud (Spearman's r = .172, p = .294). This weaker association (compared to the correlations with Reciprocal Teaching or Structured Engagement) could be due to the fact that this strategy is teacher-focused. Think Aloud had a positive and significant association with Reciprocal Teaching (Spearman's r = .320, p = .047), which 89.8% self-reported to use at least once a unit. Think Aloud was positively associated with each of the other strategies as well, but these correlations were not statistically significant. This strategy had a positive but non-significant association with Structured Engagement (Spearman's r = .243, p = .136), which was also reported as being used frequently. Reciprocal Teaching had a positive but non-significant association with Structured Engagement (Spearman's r = .215, p =.188), but was found to have essentially no correlation with Sentence

Starters (Spearman's r = .045, p = .785). The association between Think Aloud and Vocabulary instructions was also close to zero and not statistically significant (Spearman's r = .085, p = .611), which suggests that the use of Think Aloud does not necessarily mean that a teacher would also use Vocabulary Instruction at a high frequency as well. Vocabulary Instruction had a positive correlation with the four other strategies. However, the correlations were generally lower for the four strategies to Vocabulary Instruction and were not statistically significant at the .05 level. Think Aloud, Sentence Starters, and Structured Engagement were the most frequently reported strategies, so the association with Vocabulary Instruction, which was the lowest frequency, should be lower, but still positive. As I said above, Vocabulary Instruction and Think Aloud, the most frequently used strategy on the questionnaire, had a Spearman's r = .085. Sentence Starters was one of the second most frequently used strategies according to the questionnaire and had a positive but not statistically significant association with Vocabulary Instruction (Spearman's r = .107, p = .522). Structured Engagement and Vocabulary Instruction also showed a positive but not statistically significant association (Spearman's r = .193, p = .245) which was a little larger than the other four strategies. The literature calls out Vocabulary Instruction as imperative for EL support, so perhaps this means teachers need more support in planning vocabulary support for their ELs.

Other Strategies Shared

In the questionnaire, 36 of the 39 teachers shared other strategies they used in their classroom. The strategies teachers stated are connected to Sentence Starters, Structured Engagement, Think Aloud, Reciprocal Teaching, and Vocabulary Instruction. Table 4.4 shows the trends in the open-ended responses on the questionnaire. For example, in the first row of data,

28 out of the 36 respondents on that question said that partnering an EL with a bilingual student is a strategy they use and I included an example of what a teacher respondent said.

Table 4.4. Additional strategies reported by teachers on questionnaire (N=36).

Strategy	N	%	Examples of Teacher Responses
Bilingual Partner (Reciprocal Teaching, Structured Engagement, Vocabulary Instruction)	28	78	Class partner who translates when necessary and partner work with bilingual students seems to help
Graphic Organizers	23	64	I use an interactive notebook where students can house all their notes and vocabulary. This is where they draw and glue graphic organizers, foldable, exemplars, and other notes (such as generic questioning and sample sentence frames for group discussions).
Word wall (Vocabulary Instruction)	13	36	Word Banks are provided for them on the board and in supplement sheets that they can reference when writing a response
Teacher Translates (Think Aloud, Vocabulary Instruction)	8	22	I check in with her and speak to her in Spanish.
Dictionaries (Vocabulary Instruction)	3	8	For them, I allow them to use a chrome book to translate whatever word problems or words/phrases they need translated in order for them to access the content.

The most common response as seen in Table 4.4 is the use of a bilingual partner. Bilingual partners can help ELs with explaining the math in their native language (Reciprocal Teaching), engaging the EL students in structured discourse (Structured Engagement), and translation of vocabulary (Vocabulary Instruction). The use of a bilingual partner helps students comprehend what is occurring in the lesson, but no teachers specifically shared how this would develop language skills in students. Partnering EL students with native language speakers has been a strategy shared to teachers as tools to support Reciprocal Teaching and Structured Engagement in district-wide professional development. The second most stated strategy was the use of graphic organizers. As reviewed in Chapter 2 Graphic Organizers help students visually make connections between concepts or processes. Depending on how the graphic organizer is used it can support Vocabulary Instruction, Reciprocal Teaching, Structured Engagement, and can include sentence starters. The use of a Word Wall was also called out as a strategy by 13 out of the 36 respondents.

Placing vocabulary words on a wall in the classroom is a vocabulary support, for students to reference while listening, writing, and speaking. The teacher translation strategy was stated by eight of the thirty-six respondents and may help students with comprehension as students are developing their English language abilities. Three teachers stated they used dictionaries, but as tools for translation rather than English to English, which is the support students get on the SBAC.

Use of Strategies: Observations and Interviews

The observation data contrasts with the questionnaire data because Vocabulary Instruction was one of the most observed strategies used in the classroom observations. In table 4.5, if a teacher used one of the five strategies called out in the questionnaire at least, I marked a "yes" as it was observed; if the teacher did not implement the strategy, I marked "no." The last row shows the number of classrooms in which I observed the strategy. I saw Vocabulary Instruction in five out of the seven classrooms. In contrast to the questionnaire responses, Think Aloud was the least observed strategy in the observed classrooms.

Table 4.5. Summary of strategies and interactions observed in classroom lessons (N=7).

Teacher	Course	# ELs in the Class	Sentence Starters/ Frames	Structured Engagement	Think Aloud	Reciprocal Teaching	Vocabulary Instruction	# Interactions
Ms. Berger	Algebra 2 (Grade 10)	6	Yes	Yes	No	Yes	Yes	35
Ms. Cabras	Grade 8 Math	4	Yes	Yes	No	No	Yes	12
Mr. Calderon	Algebra 2 (Grade 11)	12	Yes	No	Yes	Yes	Yes	53
Ms. Esteban	Algebra 1 (Grade 9)	7	No	Yes	Yes	Yes	Yes	39
Ms. Leiva	Algebra 1 (Grade 9)	12	Yes	Yes	Yes	Yes	No	47
Ms. Medrano	Grade 6 Math	7	Yes	Yes	No	No	No	10
Ms. Phillips	Grade 7 Math	7	Yes	Yes	No	No	Yes	22
Count			6	6	3	4	5	

The interviewed teachers echoed some of the other strategies from the questionnaire respondents as well. Each of the interviewed teachers called out bilingual partners as important to having strong structured engagement. Ms. Esteban stated, "I put my ELs with Spanish speakers because they need that support. Like for [points to location of EL's seat] his "y" partner asks him questions and speaks to him in Spanish. I want my students justifying and practicing the language. I am explicit on what I plan and what I say to our students to help them because they need the support." Ms. Leiva uses graphic organizers "to help students see how different topics are connected and make it clear what the key ideas of a lesson are." Ms. Leiva was the only teacher to use a graphic organizer when observed, the other six did not use one. Overall the teachers shared strategies that correspond to the main strategies asked about in the questionnaire. The frequency of use of these other strategies was not investigated.

Findings Related to Research Question Two

My second research question asks about how EL strategies are used in their classrooms. Through the observations and interviews, I found that through strategically backwards planning their lessons, teachers used Structured Engagement as a routine in their classrooms to create discussion and used Structured Engagement in tandem with Sentence Starters, Reciprocal Teaching, and Vocabulary Instruction. The teachers also discussed in the interviews that a positive culture was a necessary condition in a classroom to implement their language development strategies. Research did not specifically influence these teachers' use of strategies; it was mostly school site professional development that influenced the use of strategies. The teachers stated they assumed the professional developments were research-based. From the questionnaire, teachers asked for professional development to provide more time to experiment and plan using strategies and clear examples of how to implement EL strategies in math lessons.

Implementation of Strategies as Routines

The most common strategies observed and discussed in the interviewed and observed teachers were sentence starters/frames and structured engagement. In many cases, I observed these in tandem. The students explained their thinking of a math problem to a partner and used sentence starters to help facilitate the conversation. For example, Ms. Medrano had a slide in her Power Point after each activity for students to process the math they just worked on. She used structured engagement with sentence starters called Think, Write, Discuss, Report (TWDR):

> The sentence frames are almost the same every time, "Do you agree or disagree?" So I'm only changing the key pieces. So it's something that my PowerPoints get reused and I'm only changing the information on there, but the flow of them is the same.

Medrano stated that at first "I don't see how that comes out in my lessons. I didn't understand how to get them to talk in math," but once she observed a History colleague implement TWDR with her same grade level she understood how to embed TWDR as a routine. She created a routine in her classroom, where students have the opportunity to share their thinking to each other but also have a sentence starter to support the conversation.

Ms. Esteban used structured engagement. However, instead of pairing the strategy with sentence frames, she used pre-written questions that the students posed to each other to facilitate discourse. Ms. Esteban explained in the interview that this discussion was part of the daily routine. However, the problems and questions change with each lesson. "I think it's more powerful to have students ask questions. Math is about questions," Ms. Esteban said. For example, in the lesson observed about solving systems of equations, partner y asked their partner f(x):

1. Read the system.
2. Why is it a system?

3. What are we trying to find? What is the definition of solution?
4. Can we use the graphing method? Why or why not?
5. Can we use the substitution method? Why or why not?
6. Find the solution of the system. Use any method.

Partner f(x) answered these questions for a particular problem. Then the partners switched roles for another problem. After both students had a chance in each role, they summarized what they had learned to each other. In the observation, students engaged in this discourse actively and quickly, showing that this type of discourse was used often as a routine in the classroom.

Ms. Leiva used structured engagement as a routine in her classroom and blended in Reciprocal Teaching, Think Aloud, Sentence Starters, and annotations to help students collaboratively understand the math. Ms. Leiva, in the observation, used structured engagement to help students read about math properties. She used Think Aloud to model how she wants student to summarize what they learn from a reading. Each partner had a different role with summarizing different readings that they will teach to their partner after (reciprocal teaching). To support the students with summarizing, Ms. Leiva had the students read the text three times with a different purpose each time (i.e., skim, talk to the text, highlight key information) and has sentence starters for the summary statement. Leiva says, "I love teaching them to summarize… that is a skill they can walk out of here with. If they walk out of here not knowing any math, they can at least summarize." Leiva said she tries to incorporate summary daily in her lessons. Ms. Leiva stated in her interview that students work in partners daily, so she uses that as a basic routine that she can adapt depending on the activity.

Ms. Cabras had students justify their solution in words on their exit ticket, so she had students practice justifying with TWDR for pre-planned questions that asked students to justify

throughout her lesson. Students enter her classroom and ask her, "Do we get to talk to our partners, today?" which shows her that she has built the consistency in her room for students to know they are discussing in structured engagement.

Ms. Berger focused her class on group work as stated in the interview and observed in her lesson. The students work in groups of four through lessons at their own pace, every day. Before getting credit to move on to a new lesson, students had to answer all the parts of their various tasks and be able to explain to each other. Ms. Berger verbally checked in with each student in a group. Unless all members can synthesize the key learnings of the lesson from her pre-planned questions, the group cannot move on. Throughout the observation, students both learned from and taught each other (reciprocal teaching and structured engagement). There was not a dominant member of any group. ELs were not easy to identify because they participated as actively as the other members of their groups. For students who needed extra support, Ms. Berger pointed them to the board, where there were sentence starters and a word bank, then asked students to restate what they were thinking. Ms. Berger created a routine for how students collaborate and discuss together in their groups using structured engagement and added other supports as needed.

Mr. Calderon does not use structured engagement to facilitate discourse in his classroom, but had a different routine that he used daily according to his interview. In the observation, he structured his lesson so, in notes he verbally explained his thinking of how to approach solving the problem with a Think Aloud, then called on students to help articulate the steps used to solve that they wrote out. Then students worked on a similar problem in groups and used the problem in their notes as a model. During the interview, Mr. Calderon confirmed that this is his how he structures all his lessons. During the observation, one new-to-the-country English Learner, Ana, explained to two students in Spanish how to solve the problem, then she reviewed her notes to read

the steps of solving in English and then used Reciprocal Teaching to help an English Only student at her table. This process was repeated five times in the lessons. Calderon stated, "it's a routine that you build into."

Classroom Culture

To help facilitate structured engagement, five of the seven observed teachers stated that they used data such as math diagnostic data, previous exams, EL language status, and grade data to create a seating chart. Esteban, Leiva, Phillips, and Medrano had student desks labeled North/South/East/West, A/B, or f(x)/y so they can assign roles to of each student. These teachers created strategic partners according to math ability and language ability. Lower students were paired with mid-level students, and mid-level students were paired with high students. This made the ability differences less drastic, so students supported each other within their zone of proximal development and grow from the experience. Ms. Medrano said in the interview, "… I'll be more specific and put all my B's, like my lower students on the right hand side, so my B is the one asking the questions and my A, the higher level student goes first." Medrano used her seating chart to guide what role in questioning students had in the class. Ms. Berger also grouped students based on data, but does not label their seats. Berger helped students practice talking in groups because, "… you know that learning is a community activity. No one can learn on their own. The process of learning happens through communication." Students are not given a specific group role, but they are all held accountable to verbalize their learning to Ms. Berger, so the students rise or fall as a group. These teachers have students change seats at least once a quarter after an assessment and use that data to guide their new seats. Students' seats change often so they have to learn to work with different people throughout the year.

Ms. Cabras and Mr. Calderon, the teachers who did not use specific data, focus on the culture of the room for their seating chart. Ms. Cabras let students pick their seats to help them build some ownership to make a good choice for themselves, but she encouraged her ELs to sit closer to her so she can check on them while she circulates. Mr. Calderon's EL students had a lot of tension with the English Only students in his class, "in the beginning they wanted to fight, because they are accustomed to EL classes where they can speak in Spanish, and my kids who don't speak Spanish, they were assuming they were talking about them. They called each other out. So I had to build my culture."

Culture stands out as a way to help ELs feel safe to participate in language development in the classroom. Berger said in her interview:

> I think they (ELs) feel comfortable enough to share in the class, but there is always some hesitation there. It is definitely better now than the beginning of the school year. Just so everybody feels that what they have to share is valuable whether it is right or wrong. Making people feel comfortable saying something even if they can't fully explain it yet, but put some pieces together. … they have worked with different people in the class and kind of have the sense of the class culture.

The students in Ms. Phillips's class set goals for how they will work in groups, and Esteban's students self-rate themselves as a partner on a rubric. The teachers encouraged their students throughout the class period and the teacher interacted directly with their EL students approximately 35 times in a 100-minute block. The ELs in these classrooms participated in all the activities. The teachers communicate to their students that they want them to learn. Ms. Cabras said, "I want you to struggle with it (the math) because that's how you learn." Ms. Phillips taught her students about growth mindset and said,

> I can keep pushing and pushing and pushing them and they love it because they know the more I challenge them, the more they learn, but it's my goal to get everyone thinking that way, that if I'm pushing them it's because I'm trying to help them learn.

In Ms. Esteban's class a student did not know how to answer a question when she called on him and Ms. Esteban did not correct him, she guided him use his notes and partner to uncover the solution.

Backward Planning

The seven teachers have a strong belief that ELs deserve the same level of instruction as non-ELs. They stated in the interviews that they pushed themselves to backwards plan to think about language. Backwards planning is the process in which teachers plan lessons based on the final product they want a student to produce at the end of lesson or unit. Ms. Esteban taught ninth grade Algebra 1. She builds her classroom experiences around what she wants students to be able to do by the end of the period:

> Backwards planning is the key, so I always start with the end. This is what I want my students to be able to produce. These are the questions that I want them to answer at the end of the period. I then backwards plan which activities I'm going to create and what discussions I'm going to have…. The questions are one of the most important parts and help make thinking visible…They are participating and practicing the language when asking. And they are practicing and listening to their partners as well. The questions have the vocab in it.

Ms. Berger echoed the same sentiment in her interview: "The main takeaway points are always very clear. The questions. The guided questions and our discussion after, make sure they are on the right track with those things." The teachers designed consistent routines for EL language

development. The main routine observed and discussed was structured engagement. Teachers provided students opportunities to discuss mathematics in partners or groups. Often this structure was paired with sentence starters/frames, reciprocal teaching, and vocabulary instruction. The teachers emphasized how they had to plan explicitly for these opportunities for student discourse prior to implementing the lesson. In response to research question 2, the teachers observed and interviewed, applied structured engagement into their classrooms as a vehicle for other EL strategies. The teachers called out planning as an essential piece to creating a positive classroom culture where all students, including ELs, can actively participate.

Research Influence

The second part of research question two asks how research may or may not have influenced these teachers. When asked on the questionnaire, "What kind of past training have you received concerning working with ELs in math classrooms?", professional development at the school site is the most frequent response, as seen in Table 4.6.

Table 4.6. Types of Past Training on Supporting ELs (N=39).

Past Training on Working with ELs	N	%
Teacher Education Program	27	66
District Professional Development	21	51
School Site Professional Development	37	90
Coaching with coach or evaluator	21	51
A colleague	11	27
Outside Professional Development	7	17
None to support ELs	1	2

The teachers who were interviewed spoke about the importance of school site PD as well. Ms. Berger said her work was most influenced by her school site professional development and an English teacher who took the role of a school site EL lead, "she has a lot of strategies. It's good to have people in the English department helping because they have a better understanding of it." This EL lead was able to help her see how to adapt general EL strategies to math. Ms. Leiva also

discussed how her school-site professional development pushed her to analyze language in her curriculum. Leiva stated, "My second year, it was an initiative in my school, I was in a strong math team, so we were wanted to bring literacy into math. We had English teachers come into our department meetings to try to talk to us about reading, writing, and text based questions. A lot of strategies they use in English class, we were trying to translate into a math class… after my second year with working on literacy, it became second nature." Ms. Medrano said that "our vice principal modeled it for us in PD, and I thought it was cool, … I didn't understand how to get students to talk about math. Kind of using this strategy and going to see another teacher and seeing the way they did it, I was able to go, ok, I see how you are embedding that into your lesson." Ms. Cabras talked about her school site PD and collaborating with other teachers as the way she learned how to support ELs.

At Ms. Esteban's school, they learned a routine called Reading Apprenticeship (RA), which is a blend of think aloud, vocabulary instruction, and structured engagement. Esteban said, "There are two things that changed my teaching significantly, RA where you just learned that by reading in math you are making your thinking visible. One of our teachers brought RA to our school. And Jo Boaler's *Math Mindsets*." She called out an outside reading that was part of district and external professional development as well as her school site professional development. No other teacher mentioned books or conferences that they had participated in. Only Mr. Calderon from the interviewed teachers mentioned his credentialing program as an influence on his use of EL strategies. He also called out "collaboration with teachers." It was not as clear how research influenced their implementation of EL strategies. Ultimately, school site collaboration in tandem with professional development is what teachers say influenced their practice with applying EL strategies.

Continued Support

On the questionnaire, teachers were able to share what supports they needed to support their ELs. The teachers shared barriers that they face in implementing strategies and what kind of training they would like. The barriers are summarized in Table 4.7. These barriers can help guide professional development for the teachers to counteract these effects. The most common barrier teachers shared in the questionnaire was time to plan for strategies. Perhaps these teachers are seeing planning for their special population of ELs as separate from their daily planning or they need more process time as educators to understand and practice using the strategy. Teachers also shared concerns about helping their ELs actively participate in discussion in their classrooms. There can be many reasons for why teachers stated this, but it emphasizes a need for teachers to understand how a strategy is used not just what the strategy is. Ten of the teachers shared that monitoring if a student uses a strategy is a barrier to implementation, as well as monitoring ELs' language progression with the use of a strategy. Addressing the monitoring aspect of a strategy could perhaps help support teachers more.

Table 4.7. Barriers to Implementing EL Strategies (N=39).

Barrier	N	%	Examples of teacher responses
Time to plan	20	51	There is not enough time to plan specifically for EL students.
Engaging ELs	12	31	I think the biggest challenge I am facing this year, in particular, is student participation. If students are apathetic, as a whole group, then it makes it hard to implement smoothly … sometimes I've noticed students are inclined to just give their partners the work and they copy instead of explaining to each other.
Monitoring implementation	10	26	I don't know how to monitor student success and sometimes it's hard to check how students are using a support like structured engagement…. I don't know how to measure if ELs are progressing language-wise.
Understanding Specific Student Needs	10	26	I wish I had more time with an EL specialist who could break down specific needs (bridging, expanding, emerging) per student. I don't know how to differentiate for all their needs.

Another piece that would help teachers' guide their instruction is understanding each of their EL's specific language needs. This helps teachers understand what strategies they should use and why they need to use those strategies. In the questionnaire, 26% of the respondents said this

was a barrier to supporting their ELs. To really support ELs, teachers need to understand who their students are and what they need to grow in their language abilities. In the interviews, Ms. Berger was the only teacher to say she wondered how to specifically support her EL students who are also designated as students with special needs:

> almost all my EL students also have IEPs (individualized educations plans) … I don't know where the biggest need is for them, am I supporting their language needs or more of their general learning needs in math, many of the strategies on their IEPs are the same as what my ELs need.

Understanding students' language abilities and other elements that may affect their learning would help teachers tailor their lessons to support the ELs at their current levels and continue to push them to grow.

The feedback from teachers on the questionnaire about professional development addressed many of these concerns. Overall, they ask for examples of how EL strategies work in math classrooms and time to plan for these strategies. One teacher stated on the questionnaire, "Time to process strategies and plan for these strategies. We are given a lot of information sometimes but we get little time to practice or plan for it." All the respondents said that math-specific examples of implementation would help them. One teacher articulated it as "actually focus PD on math classes/content; most PD on EL support give general suggestions or specific ideas for English/History classes; we get very little direct support for Math." The focus on the how of implementation was important to these teachers. A respondent said,

> My teacher education program did a good job of making sure everyone was researching EL strategies. Implementation, however, was not as emphasized. My professor did a lot of

research with EL strategies and helping districts implement them, but she even did not have enough knowledge in implementing a variety of strategies in a math classroom.

Thirty of the thirty-nine respondents stated how modeling and videos would help them understand how to support their ELs as well. This could address the question of how to implement strategies well. One teacher asked, "how do we measure how students are improving with language when we are measuring more on how well they get the math?" which echoes what ten teachers said on the barriers to implementation question on the questionnaire (Table 4.7). As part of professional development, it would be important to support teachers in understanding how to track student language progress while implementing language development supports. The interviewed teachers echoed many of the same sentiments that they wanted to continue to grow and practice using language development strategies.

Findings Related to Research Question Three

My third research question is addressed in parts of my questionnaire, where I tried to establish how teachers felt about possible attitudes towards supporting ELs, whether a teacher felt prepared to support ELs in math class, and possible extrinsic factors that may affect their implementation of EL strategies. The online questionnaire included items measuring each of the hypothesized factors. These hypothesized factors are represented in Figure 3.1. I examined the relationships among these items and collapsed some in order to create composite scores (scales) for these factors. Finally, I examined the correlations among these factors and with the implementation of EL strategies.

Table 4.8 shows the correlations among the five questions focused on teacher attitudes towards ELs. Statements 8b, 8c, and 8d were most strongly associated. Therefore, I combined

these there variables to construct an "Attitude" (Cronbach's alpha = .545). I then examined the associated between scores on this scale and the implementation of EL strategies (Table 4.10).

Table 4.8. Attitude towards supporting ELs (N=39).

	Strongly Disagree (1)		Disagree (2)		Agree (3)		Strongly Agree (4)		M	SD	Spearman Correlations				
	N	%	N	%	N	%	N	%			(8a)	(8b)	(8c)	(8d)	(8e)
8a. I'm a math teacher and a literacy teacher	0	0	2	5.1	19	48.7	18	46.2	3.41	.59	1.00				
8b. It's unrealistic for me to differentiate my lessons every day for my ELs^	4	10.3	26	66.7	8	20.5	1	2.6	2.15	.63	.275	1.00			
8c. My EL students are not motivated to try in math class^	12	30.8	23	59.0	4	10.3	0	0.0	1.79	.61	.040	**.391**	1.00		
8d. I don't expect to see a difference with EL student outcomes whether I implement EL strategies or not.^	17	43.6	17	43.6	5	12.8	0	0.0	1.69	.69	.285	.241	.250	1.00	
8e. I want to teach the same thing to all my students.	5	12.8	11	28.2	16	41.0	7	17.9	2.64	.93	-.067	-.003	.161	.147	1.00

Notes: ^ indicates questions that were reverse coded. Correlations with p<.05 shown in bold.

Next, I looked for associations with the perceived level of preparation of teachers (Table 4.9). Statements 8h and 8i were positively associated ($r = .452$, $p < .05$) and deal with "time." Statements 8f and 8g were positively associated ($r = .361$, $p < .05$) and relate to feelings of preparedness. Based on these results, I constructed a "Time Preparation" scale from items 8h and 8i (alpha = .658) and a "Feeling Unprepared" scale from items 8f and 8g (alpha = .549).

Table 4.9. Perceived level of preparation to support ELs (N=39).

	Strongly Disagree (1)		Disagree (2)		Agree (3)		Strongly Agree (4)		M	SD	Spearman Correlations				
	N	%	N	%	N	%	N	%			(8f)	(8g)	(8h)	(8i)	(8j)
8f. I feel unprepared to support ELs.	2	5.1	17	43.6	19	48.7	1	2.6	2.49	0.64	1.00				
8g. I want to do more to support my ELs but I don't know how.	1	2.6	13	33.3	21	53.8	4	10.3	2.72	0.69	**.361**	1.00			
8h. Even if I knew how to support ELs more, I don't have the time because I'm being pulled in so many directions.	2	5.1	15	38.5	16	41.0	6	15.4	2.67	0.81	.192	**-.316**	1.00		
8i. I don't know how to make time to plan for my ELs specifically.	3	7.7	14	35.9	19	48.7	3	7.7	2.56	0.75	.108	.129	**.452**	1.00	
8j. The pacing is too hard in my content to differentiate for my ELs.	2	5.1	24	61.5	13	33.3	0	0.0	2.28	0.56	.174	.273	.135	.076	1.00

Notes: correlations with p<.05 shown in bold; correlations with p<.01 shown underlined.

The correlations among strategies and their hypothesized influences are shown in Table 4.10 (a complete table of Spearman correlations for individual survey items is provided in Appendix E). These correlations may be attenuated due to measurement error in items and multi-item composites. Feeling unprepared to support ELs and not having enough time to prepare was positively associated with the frequency of use of Vocabulary Instruction (Spearman's r = .373, p < .05), while and was inversely associated with feelings of support (r = -.588, p < .01) and reward (r = -.366, p < .05).

Table 4.10. Correlations among uses of strategies and hypothesized influences on use (N=39).

Variable/Score	M	SD	Spearman Correlations									
			(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Use of Strategies												
(a) Sentence Starters/Frames	2.18	1.23	1.00									
(b) Structured Engagement	2.08	1.04	.310	1.00								
(c) Think Aloud	1.77	2.21	.172	.243	1.00							
(d) Reciprocal Teaching	2.21	0.92	.045	.215	**.320**	1.00						
(e) Vocabulary Instruction	2.95	1.11	.107	.193	.085	.109	1.00					
Hypothesized Influences												
(f) Attitude (3 items, alpha = 0.545)	9.359	1.405	-.048	-.197	.070	.063	-.105	1.00				
(g) Time Preparation (2 items, alpha = .658)	5.231	1.347	-.022	.166	.216	.022	.304	**-.530**	1.00			
(h) Feeling Unprepared (2 items, alpha = .549)	5.205	1.22	.032	.238	.084	-.075	**.373**	-.107	.017	1.00		
(i) Support	3.08	.77	**-.350**	-.196	.096	-.012	-.048	.039	.073	**-.588**	1.00	
(j) Reward	2.26	.72	-.121	-.016	-.128	.159	.102	.132	.184	**-.366**	**.443**	1.00

Notes: correlations with p<.05 shown in bold; correlations with p<.01 shown underlined.

Sentence Starters

Sentence Starters and the hypothesized influences mostly have negative associations. The only statistically significant association is between Sentence Starters and feeling supported by my peers, administrators, and curriculum specialists to implement EL strategies (Spearman's r = -.350, p =.029). The teachers who use sentence starters frequently, do not feel as supported by other people in using language development strategies. There is also a negative but non-significant association between frequency of use of Sentence Starters and feeling rewarded to support ELs

(Spearman's r = -.121, p = .463). Not feeling rewarded to support ELs is associated with using Sentence Starters frequently. A positive attitude towards supporting ELs, as well as feeling you have enough time to prepare for EL strategies, also have weak and non-significant negative correlations with Sentence Starters (Spearman's r = -.048 p= .772, Spearman's r = -.022, p = .894). The only positive association (but still not statistically significant at the $p < .05$ level) with a hypothesized influence that Sentence Starters had is with feeling unprepared to support ELs (Spearman's r = .032, p= .847). This means that there is a connection between feeling unprepared and frequency of use of Sentence Starters. Perhaps this means that Sentence Starters is an easier strategy for teachers to implement because teachers do not need as much support, time, positive attitude, or rewards to increase implementation and it does not take as much time to plan for implementation.

Structured Engagement

Structured Engagement also had some positive and negative associations with the hypothesized influences. The variable with the largest positive association with Structured Engagement was feeling unprepared (Spearman's r = .238, p =.144), but this association was still not statistically significant. Feeling prepared had negative correlations with frequency of use of Structured Engagement. Not feeling that teachers have enough time to prepare for ELs had a positive but non-significant association with use of Structured Engagement (Spearman's r =.166, p= .313). This seems counterintuitive; as with Sentence Starters, I expected that feeling like you do not have enough time to prepare would have a positive association with use of a strategy like Structured Engagement. Structured Engagement had negative but non-significant correlations with both the scale attitude and feeling of support factor (Spearman's r = -.187, p = .229 and Spearman's r = -.196, p=.232, respectively). Perhaps this means the use of Structured Engagement

is not as purposeful for ELs specifically but used as a general classroom strategy that is not too difficult to implement.

Think Aloud

Teachers indicated that they used Think Aloud the most frequently in their lessons. The scale attitude factor and feeling supported all have positive yet low magnitude associations with Think Aloud. It is the only strategy that has both these factors as a positive correlation, which makes more sense intuitively that these positive feelings would positively associate with using Think Aloud more. The feeling of not enough time to prepare had a positive but not statistically significant association with Think Aloud (Spearman's r = .216, p = .186). The feeling of being rewarded had a negative but non-significant correlation with frequency of use of Think Aloud like feeling rewarded was with Sentence Starters and Structured Engagement (Spearman's r = -.128, p = .438).

Reciprocal Teaching

Reciprocal Teaching was not significantly associated with any of the hypothesized influences. The frequency of use of Reciprocal Teaching had a weakly positive but not statistically significant correlation with the feeling there is enough time to prepare for ELs in a classroom (Spearman's r = .022, p = .893). Reciprocal Teaching was the only strategy that had a negative (albeit only weakly negative and not statistically significant) association with feeling unprepared (Spearman's r = -.075, p =.648). So feeling prepared was positively associated with the frequency of use of this strategy. Reciprocal teaching also had a positive but not statistically significant association with feeling rewarded when using a strategy (Spearman's r = .159, p = .335).

Vocabulary Instruction

The hypothesized influenced showed a variety of positive and negative correlations with Vocabulary Instruction. Vocabulary instruction was reported as the least frequently used strategy in the questionnaire, which made the correlations more interesting. A positive and statistically significant association to note is between feeling unprepared to support ELs and the use of Vocabulary Instruction (Spearman's r=.373, p= .021). The scale value of time for preparation also had a positive but not statistically significant association with the frequency of use of Vocabulary Instruction (Spearman's r = .304, p = .064). Feeling that there is a reward for supporting ELs has a weakly positive but not statistically significant association with Vocabulary Instruction (Spearman's r = .102, p =.543).

Conclusions

Overall, my findings were that teachers want more support overall with enabling factors for implementing EL strategies. A feeling of unpreparedness may affect use language development strategies, specifically the frequency of use of Vocabulary Instruction. This feeling of unpreparedness is also inversely associated with feeling rewarded and supported for using EL strategies. According to the interviewed teachers a positive classroom environment is needed to create the atmosphere for a discussion-rich classroom. Purposeful planning helps teachers create the experiences of language that EL students need. Teachers find that using language instruction, particularly Structured Engagement, as a routine helps EL students more, which was also one of the most frequently used strategies stated on the questionnaire. Teachers want to learn more about how to implement strategies in their classrooms and how to monitor language development with each strategy they use. Professional Development could also help address the feelings of unpreparedness and help teachers feel efficacy in Vocabulary Instruction.

CHAPTER FIVE: DISCUSSION

Introduction

This study adds to the research to better understand the gap of implementation of research-based language development strategies for ELs in math classrooms. The problem persists that EL math students do not perform as highly on high-stakes exams and many secondary math teachers state they struggle with supporting the EL teachers in their classrooms (Abedi, 2006; Ross, 2014). For this project, I looked to answer my research questions using mixed-methods to get a more robust understanding of what teachers say are helpful EL strategies and are used the most, how they incorporate EL strategies, and what may influence their implementation. I sought to find what may influence math teachers' implementation of EL strategies using an adaptation of the Proceed-Precede model (Crosby & Noar, 2011). I will share the research with the district to help them create meaningful Professional Development to support math teachers in creating the positive discourse-rich classrooms that EL students deserve. In this chapter, I will first discuss the findings from Chapter 4, then discuss the limitations of the findings, and then the implications for future research.

Discussion of Findings

One of the overall trends in my findings was the need for Vocabulary Instruction support. Vocabulary Instruction was the strategy teachers stated they used the least frequently and had a positive association with feeling unprepared to support ELs and having enough time to plan for EL supports. When language is not a barrier, ELs can achieve at the same level as non-ELs (Abedi & Lord, 2001). Understanding the language of mathematics is important to student comprehension of the math, but also for students to gain ability to explain and justify their thinking (Chamot, 2009; Moschkovich, 1999; Zweirs, 2017). It is up to educators to amplify the language in the classroom

to help ELs practice using the language of the discipline. As the interviewed teachers stated this requires purposeful planning based on the language they want to see students use.

To support teachers in understanding how to implement stronger Vocabulary Instruction, teachers said on the questionnaire they wanted math-specific examples of the strategy, how to monitor the strategies use, how to monitor language development, and an understanding of who their ELs are. The interviewed added another layer to the strategies by saying that they tried to use strategies as routines in their classrooms. This makes me think that PD should focus around the newer "Math Language Routines" from UL/SCALE at Stanford University (Zweirs, 2017). These strategies are math-focused routines to support language in the classroom (Appendix A). Furthermore, teachers need continued support with understanding their ELs and what their specific needs are to help them grow.

Overall the hypothetical factors that influence behaviors gave me limited information, but helped see some associations between possible factors and frequency of use of strategies. Both frequency of use of Sentence Starters and Vocabulary Instruction had some significant associations with the hypothetical influences. None of the hypothetical influences had similar associations across every strategy, but I had expected more statistically significant correlations. There were some connections between teachers feeling prepared and how rewarded and supported they were. This pushes me to think that there were revisions needed for the survey and a revision needed for my proposed Precede-Proceed Model. Based on these results, I would revise the model presented earlier (Figure 3.1) to show the importance of the possible enabling factors (Figure 5.1). The interviewed teachers stated how important classroom culture and backwards planning was in creating meaningful experience for their ELs. Feeling prepared also had a positive association with the strategy teachers' implemented the least. I would be interested in investigating how

targeting these enabling factors may influence a change in teacher behavior. Feeling rewarded has an association with feeling prepared, so I perhaps investigating how Reinforcements influence these proposed Enabling factors, will help make it clear how they are connected. The proposed reinforcing factors had little association with the behaviors, so that is why I moved them one step back, so if they are more strongly connected with various enabling factors. The questionnaire had some questions about possible predisposing factors and respondents tended to state they had positive beliefs in the ability of ELs and in their role as support for ELs. To build a positive classroom environment, I think a teacher would need to believe in the importance of these possible enabling factors as a part of their practice. That is why I propose moving the predisposing factors a step ahead that may influence the conditions a teacher needs to implement EL strategies.

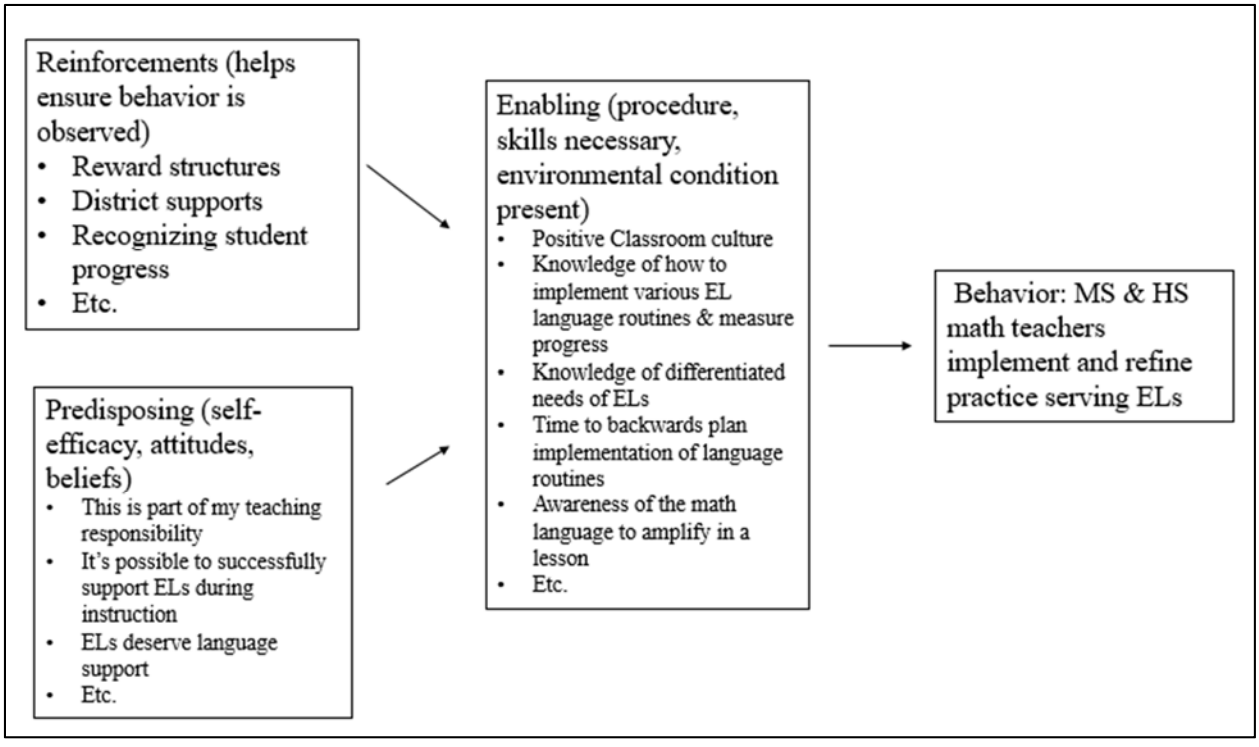

Figure 5.1 Revised possible factors affecting math teachers' behavior.

Limitations of Findings

Some limitations to the study are the reactivity. Now analyzing the data, I look back and wonder if I should have changed some of the survey questions. Perhaps the questions especially about teacher beliefs in student ability created reactivity in my study. Some teachers said they felt their students were unmotivated on open-ended questions in the questionnaire but most disagreed with a statement that said EL were unmotivated to do work. I wonder whether I would have seen stronger correlations between my hypothetical factors and the behaviors if the questions had been worded differently or if I had obtained more reliable measurements. I tried to contend with the reactivity in my survey by also observing and interviewing teachers.

The greatest risk to my study was reactivity. While filling out the survey, teachers may have answered with what they thought were the "right answers," rather than providing answers reflecting their actual beliefs and actions. Similarly, the participants may have acted differently in their classroom during my observations because they knew that I am looking for EL strategies. For example, they may have chosen to highlight the use of EL supports during their lessons in a way they normally do not. I asked the teachers during the interview if what I observed was indicative of their common practice and if not, why. The teachers also knew that I was interested in learning how EL strategies were used in their class during their interviews. This may have made them change their responses to try to give the answer they perceive is the right answer.

Another limitation to my study was the degree to which the study was representative of all teachers in the district. The survey allowed me to get data from a wider range of math teachers and though I was also gathering observation and interview data to help deepen my understanding, it was only from a small subset of teachers. I do not know if this sample was representative of all teachers or if something drove this group to want to participate, such as having strong emotions

about the topic. The small sample size and measurement error likely affected the reliability of the individual scores, so the correlations would be smaller. I also discovered that all teachers in the district were asked to participate in another EL survey after a district EL PD given at each school site. This may have caused some fatigue with the teachers in the math department to answer similar questions more than once. The district EL survey echoed results in my survey, that teachers wanted professional development on how to best support ELs specifically in math. A related limitation was to what extent the teachers in this study are representative of math teachers in other districts and if the results are unique to this districts' environment despite choosing a district with a similar EL percentage as the state.

Furthermore, the survey and interview protocol may not have captured all the differentiation strategies teachers are using. Perhaps teachers are doing other strategies that I have not identified and the teachers did not realize were relevant to share or perhaps there were other factors affecting implementation. I was also interested in discovering how Second Language Acquisition theory affected teachers' use of EL strategies. I did not find evidence of specific research influencing teachers. Perhaps I could have seen some elements of gradual release of supports if I observed the teachers over a period of time more than once.

The Precede-Proceed Planning Model helped me to organize my proposed hypotheses but it also implies a causal relationship. The associations I used do not imply causation. This means that perhaps intervening on these possible factors may not affect teacher behavior. More research would need to be done to help learn more about the possibility of these factors having a causal relationship with behavior.

Implications for Future Research

Further investigation is needed to see what influences math teachers' implementation of EL strategies. My new proposed model in Figure 5.1 could work as a guide to see what are the factors that affect teachers' behaviors of these routines. Understanding the influences can help districts create more meaningful PD and provide more strategic supports. Furthermore, now that there are specific Math EL routines from UL/SCALE that teachers are exposed to, it may affect how teachers respond to the survey and change the associations between teacher behaviors and my hypothesized factors.

Differentiating routines for different EL populations was initially a topic I was interested in and found through my study that math teachers in this district did not adjust strategies based on their EL students' needs. In the classrooms I observed, all ELs received the same level of language support and most of the supports were also given to non-ELs. To further differentiate the study, it would be helpful to know more about the different categories of ELs such as Long Term English Learners (LTEL). Each EL has unique needs, so an LTEL compared to a new to the country student with high literacy or compared to an EL student with special needs may need different types of support in the classroom. Ms. Berger was the teacher I observed who allowed students to work at their own pace, but otherwise it seemed like a challenge for other teachers to differentiate lessons specifically for their ELs.

Implications for Practice

Teachers need continued help in supporting their ELs in math. Their school site professional development has helped them understand that strategies exist that could help their students. Perhaps with series of math specific professional development, teachers could see the specific teaching moves needed to implement EL strategies, including how to monitor for success

in the strategy. The Math Language Routines (Appendix A) are specifically called out as helpful in math classrooms, so they could help demystify how to apply a strategy in the math classroom. For math instructional coaches it would be important to continue to provide supports so teachers can build the time to plan for a discourse rich classroom. For administrators and leaders, we see that teachers are trying strategies and are willing to learn. They need to support teachers with more opportunities to develop their practice with EL strategies through observation, planning, and data analysis.

Conclusions

Teachers are at the frontlines supporting our students with developing their critical thinking skills, content, and language abilities. At a time when ELs are struggling to achieve at the same level as their non-linguistically diverse peers, this study provides some insight on what teachers still need support with to implement purposeful language development strategies for their ELs.

APPENDICES

Appendix A: Math Language Routines from UL/SCALE (Zweirs, 2017)

Math Language Routine	Explanation of Routine	Alignment to Investigated Strategies
Stronger and Clearer Each Time	Students revise their own and peers writing through successive pair shares	Structured Engagement
Collect and Display	While students discuss, the teacher captures the language students use to analyze and build vocabulary	Vocabulary Instruction
Critique, Correct, and Clarify	Students analyze and revise student work to improve the quality.	Sentence Starters Structured Engagement Think Aloud Reciprocal Teaching Vocabulary Instruction
Information Gap	A structured conversation where one student has information to solve a problem that another student needs	Structured Engagement Sentence Starters
Co-Craft Questions and Problems	Students create possible questions that could be asked about a scenario before seeing the actual question.	Structured Engagement
Three Reads	Students read a task three times and for each read they have a different purpose.	Structured Engagement Reciprocal Teaching Vocabulary Instruction
Compare and Connect	Students compare and contrast solution strategies.	Think Aloud Structured Engagement Vocabulary Instruction
Discussion Support	Teachers use various strategies to support discussion of ideas	Think Aloud Sentence Starters Structured Engagement

Appendix B: Survey

1. Consent to participate in the study: yes or no

2. What strategies do you use to support your English Language learners (ELs) such as strategic seating, dictionaries, graphic organizers, etc.?

3. How many years have you been working as a teacher __

4. In general, across the classes you've taught, how has the performance of ELs compared with the performance of non-ELs (initial/reclassified fluent English proficient and English Only)?

   Much lower, somewhat lower, similar, somewhat higher, much higher

5. To what extent do you agree or disagree with the following statements about how you felt working with EL students.

   a. I'm a math teacher and a literacy teacher

      Strongly Disagree/ Disagree/ Agree/Strongly Agree

   b. It's unrealistic for me to differentiate my lessons every day for my ELs

      Strongly Disagree/ Disagree/ Agree/Strongly Agree

   c. My EL students are not motivated to try in math class

      Strongly Disagree/ Disagree/ Agree/Strongly Agree

   d. I don't expect to see a difference with EL student outcomes whether I implement EL strategies or not.

      Strongly Disagree/ Disagree/ Agree/Strongly Agree

   e. I want to teach the same thing to all my students.

      Strongly Disagree/ Disagree/ Agree/Strongly Agree

   f. I feel unprepared to support ELs.

Strongly Disagree/ Disagree/ Agree/Strongly Agree

g. I want to do more to support my ELs but I don't know how

Strongly Disagree/ Disagree/ Agree/Strongly Agree

h. Even if I knew how to support ELs more, I don't have the time because I'm being pulled in so many directions

Strongly Disagree/ Disagree/ Agree/Strongly Agree

i. I don't know how to make time to plan for my ELs specifically.

Strongly Disagree/ Disagree/ Agree/Strongly Agree

j. The pacing is too hard in my content to differentiate for my ELs

Strongly Disagree/ Disagree/ Agree/Strongly Agree

k. I feel supported by my peers, administrators, and curriculum specialists to implement EL strategies

Strongly Disagree/ Disagree/ Agree/Strongly Agree

l. I feel rewarded and praised for supporting my EL students.

Strongly Disagree/ Disagree/ Agree/Strongly Agree

6. Use this space to elaborate on any of the statements above, if you wish.

7. To what extent are you familiar with the specific language needs of your current EL students.
Extremely/very/somewhat/not so/not at all

8. Rate your frequency of use of the five strategies are listed below:

a. Sentence Starter/Frames (example: giving an EL a post-it with this sentence "I agree with ____ because ____" to use before calling on them to respond to another student's comment)

Every lesson/every week/ every unit/ attempted more than once/ rarely never

b. Structured Engagement (examples: Think-Write-Discuss-Report, Stronger and Clearer each time, Co-Craft Questions and Problems, Information Gap, Three Reads, etc.)

   Every lesson/every week/ every unit/ attempted more than once/ rarely never

c. Think Aloud (example: teacher verbally modeling their thinking as they focus on a math problem)

   Every lesson/every week/ every unit/ attempted more than once/ rarely never

d. Reciprocal Teaching (example: students explaining how to solve a problem to their partner)

   Every lesson/every week/ every unit/ attempted more than once/ rarely never

e. Vocabulary Instruction (example: include Frayer Models, Collect and Display)

   Every lesson/every week/ every unit/ attempted more than once/ rarely never

9. What routines have you found helpful in implementing one or more the five listed strategies? For example, Vocabulary instruction: I have a section in my students' notebook for all the definitions that we cite frequently.

10. For the listed strategies, what are possible barriers to implementation? (ex: time to plan implementation, student success with the strategy, difficult to monitor use, I do not know how to implement it well, etc.)

11. What kind of past training have you received concerning working with ELs in math classrooms?

    Teacher education program/ school site professional development/ district pd/ outside PD/ coaching with a curriculum specialist or my evaluator/ colleague/ none to specifically support the math classroom.

12. What could your district or school do to better support math educators in teaching ELs?

13. What could teacher education programs do to better support math educators in teaching ELs?

14. Anything else you'd like to share? Comments? Questions?

You have reached the end of the survey. Thank you for your time and sharing your responses.

15. As you know, I'm interested in learning about the experiences of ELs in math classrooms and am interested in the challenges math teachers face in supporting these students, the kinds of approaches of strategies teachers are trying, and what they find effective or ineffective. As part of that study, I'd like to visit math classrooms in our district, in order to observe a class period and talk with teachers. Is this something you'd be willing to consider? If so, please include your email address, and I'll follow up with more details.

Appendix C: Observation Protocol

Objective:		Tally number of direct interactions of teacher with EL students	
Strategies observed & description of activity ☐ Reciprocal teaching ☐ Sentence frames ☐ Think/Pair /Share ☐ Think aloud ☐ Vocabulary Routine ☐ Other: _____			
Evidence of EL's experience being differentiated from Gen Ed (example Materials to scaffold instruction)			
Teacher feedback to EL students			

Appendix D: Interview Protocol

Tell me about your EL students.

- Talk me through your process for planning for this lesson
    - How does using EL strategies affect your pacing?
    - What type of time commitment does it take to include these supports in your lessons?
    - What data helps you understand the level of support you should give your students?
- How do you think the EL strategies you used helped your ELs?
    - How do you think using EL strategies affects students' understanding of problem solving?
- What helped you to feel comfortable in trying these strategies?
    - How did you learn about these strategies?

Appendix E: Spearman Correlations Among Survey Items

Table E.1 Correlations among survey items: uses of strategies and hypothesized influences

Item	M	SD	Spearman Correlations															
			8a	8b	8c	8d	8e	5a	5b	5c	5d	5e	5f	5g	5h	5i	5j	5k
Use of Strategies																		
8a	2.179	1.233																
8b	2.077	1.036	.310															
8c	1.769	.842	.172	.243														
8d	2.205	.923	.045	.215	**.320**													
8e	2.947	1.114	.107	.193	.085	.109												
Attitudes towards supporting ELs																		
5a	3.410	.595	-.304	**-.404**	-.150	-.035	-.221											
5b	2.154	.630	.301	**.385**	.293	.028	.072	-.275										
5c	1.795	.615	-.209	-.028	-.066	.070	.237	-.040	**.391**									
5d	1.692	.694	-.014	.134	-.282	-.113	-.076	-.285	.241	.250								
5e	2.641	.932	.154	.115	-.144	.005	.091	-.067	-.003	.161	.147							
Perceived Level of Preparation																		
5f	2.487	.644	.065	.265	.171	-.168	.269	-.176	.181	.042	.034	.121						
5g	2.718	.686	-.041	.195	-.019	.108	.289	-.137	.101	.122	-.066	**.339**	**.361**					
5h	2.667	.806	.004	.073	.135	-.073	.263	-.107	**.376**	**.369**	.179	-.150	.192	**-.316**				
5i	2.564	.754	-.025	.156	.230	.045	.221	-.312	**.380**	**<u>.421</u>**	.218	-.016	.108	.129	**<u>.452</u>**			
5j	2.282	.560	-.025	.159	-.143	-.017	-.074	.093	.239	**.348**	.305	**.380**	.174	.273	.135	.076		
Rewards and Supports																		
5k	3.077	.774	**-.350**	-.196	.096	-.012	-.048	-.004	-.048	.125	-.090	-.153	**<u>-.460</u>**	**<u>-.535</u>**	.112	.026	-.261	
5l	2.256	.715	-.121	-.016	-.128	.159	.102	.043	-.090	-.168	.020	.071	**-.373**	-.262	-.112	-.217	**<u>-.409</u>**	**<u>.443</u>**

Notes: correlations with p<.05 shown in bold; correlations with p<.01 shown underlined.

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